PUBLICATION 365
Revised Jan. 1987

PESTICIDE RECOMMENDATIONS for GREENHOUSE CROPS

Ministry of Agriculture and Food
ONTARIO
Jack Riddell, Minister
Clay Switzer, Deputy

GENERAL INFORMATION

FLOWERS

VEGETABLES

88-00115/

To the best of the collective knowledge of the members of the Ontario Crop Protection Committee, all pesticides listed in this publication were federally registered, reviewed by the Ontario Pesticides Advisory Committee and classified by the Ministry of the Environment as of November 13, 1986.

The information presented on the pesticide container label regarding application rates and methods of application is the final authority and where conflicts occur between this publication and the container label, the latter applies.

PAY CLOSE ATTENTION TO ALL INSTRUCTIONS AND WARNINGS PRINTED ON THE PESTICIDE LABEL.

The Ministry of Agriculture and Food, or the Ontario Crop Protection Committee by printing this publication does not offer any warranty or guarantee and they do not assume any liability for any crop loss, animal loss, health, safety or environmental hazard caused by the use of a pesticide mentioned in this publication.

POLICY STATEMENT

In this publication, most recommendations list several pesticides that are effective for each insect or disease discussed. Where possible, the less hazardous materials and those that growers have used satisfactorily for a number of years are listed first. These are followed by the more toxic pesticides and/or newer ones with which we have less experience. It must be emphasized that, in some cases, the most effective pesticides are highly toxic.

Weather and other factors influence the effectiveness of pesticides and the likelihood of plant injury by control chemicals. Consult the package label and other information regarding compatibility with other materials, the effect of high or low temperatures, poor drying conditions, etc. Wettable or soluble powders (WP or SP) generally are less likely to cause plant injury than liquid concentrates (EC, SC, and F).

A number of brand names of pesticides are given in the calendars as a convenience to the grower and are neither an endorsement of the product nor a suggestion that similar porudcts are not effective.

The pesticide recommendations are reviewed annually by the Ontario Crop Protection Committee. **OLD EDITIONS SHOULD BE DISCARDED.**

For additional information or clarification of recommendations, contact Ontario Ministry of Agriculture and Food personnel listed on page 2.

FEDERAL REGISTRATION AND PROVINCIAL CLASSIFICATION

Ontario's Pesticides Act and Regulation 751, administered by the Ministry of the Environment, prohibits the sale and use of pesticide products unless they are registered under the federal Pest Control Products Act and classified under the provincial Pesticides Act by being placed in one of six schedules of the Ontario Regulation.

FEDERAL REGISTRATION

There are three categories:

1. **Full Registration**

   Implies that all federal departments involved in the registration process agree that the data package was acceptable at the time of registration.

2. **Temporary Registration**

   Indicates that there is a need for additional scientific or technical information to acquire a full registration. Temporary registrations expire on the 31st of December each year and the products must be re-registered if they are to be available for use in the following year.

3. **Temporary Registration (Restricted Class)**

   Indicates that there is an urgent need for the pesticide but that studies on the safety of the product are incomplete. Such registrations expire on the 31st of December each year and the products must be re-registered if they are to be available for use the following year. The pesticide product presently carrying a temporary registration (restricted class), classified for use in Ontario and included in this publication: Afugan (pyrazophos). This material may, or may not, be available for use in 1987.

PROVINCIAL CLASSIFICATION

Pesticide products are classified into six schedules in Regulation 751 on the basis of their toxicity, environmental or health hazard, persistence of the active ingredient of its metabolites, concentration and usage. This classification system provides the basis for regulating the distribution, availability and use of pesticide products in Ontario.

A procedure has recently been put in place to upgrade the classification process for pesticide products. This procedure provides for "interim status" products. These products are proposed by the Minister for inclusion in a schedule to Regulation 751, and the proposal is published in the *Ontario Gazette*. A person who sells or uses such a product as if it were in the specified schedule, is exempt from the prohibition against sale or use of an unscheduled product.

For updated information on the regulatory status of these or other pesticides contact the Agriculture & Industrial Chemicals Section, Hazardous Contaminants & Standards Coordination Branch, Ministry of the Environment, Toronto Telephone (416) 965-2401.

CONTENTS

Policy Statement — Registration ..... Inside Front Cover
Horticultural Crop Advisors 2
Pesticide Control Officers 3
Precautions with Pesticides 4
If Accidents Occur 4
First-Aid Information 4
Emergency Procedures for Pesticide Poisoning 4
Relative Hazard to Humans 4
Blood Tests 5
Protective Clothing 5
Methyl Bromide and Insecticide Smokes 6
Reentry to Treated Areas 6
Storage of Pesticides 6
Disposal of Pesticides 6
Shelf Life of Pesticides 7
Types of Application Equipment 7
Wetting Agents 7
Alkaline Water (spray) 7
Pesticide Regulations 8
Preventive vs Eradicant Programs 8
Pesticide Toxicity 8
Cleanliness and Sanitation 9
Bench and Equipment Sterilization 9
Wood Preservatives 9
Soil Pasteurization 9
Soil Drenches 10
Compatibility of Pesticides 10
Temik 10G 10
Weed Control 11
Acidity and Alkalinity (Soil and Irrigation) 11
Major Greenhouse Pests 13
Occasional Greenhouse Pests 16
Treatment of Common Problems 19
Nematodes 19
Major Greenhouse Diseases 20
Flowers
Growth Regulators 22
Pesticide Injury to Flower Crops 26
Pest and Disease Control by Flower Crop
—African Voilet 27
—Azalea 28
—Bedding Plants 29
—Begonia 31
—Bulb Crops 32
—Calceolaria 32
—Carnation 33
—Chrysanthemum 35
—Cineraria 37
—Cyclamen 38
—Exacum 39
—Foliage Plants 39
—Geranium 41
—Gerbera 42
—Gloxinia 43
—Gypsophila 43
—Hydrangea 44
—Lily (Easter) 45
—Poinsettia 45
—Rose 47
—Snapdragon 49
Greenhouse Vegetables
—Crop Protection 51
—Biological Control 51
—Rockwool, Peat, N.F.T. 51
—Seed Treatment 52
—Cucumber Diseases 52
—Cucumber Insects 54
—Tomato Diseases 55
—Tomato Insects 57
—Lettuce Diseases 57
—Lettuce Insects 58
The Metric System 59
Related Publications ..... Inside Back Cover

HORTICULTURAL CROP ADVISORS
ONTARIO MINISTRY OF AGRICULTURE AND FOOD

Counties Served/Specialty	Name	Address	Phone No.
Greenhouse Flowers	John Hughes	Hort. Science Dept., U. of Guelph Guelph, N1G 2W1	519-824-4120 ext. 8910
Greenhouse Flowers & Nursery	Wayne Brown	Vineland Station, L0R 2E0	416-562-4142
Marketing	Bob Cobbledick	Vineland Station, L0R 2E0	416-562-4142
Eastern Ontario	Deb Hoffman	College of Agricultural Technology Kemptville, K0j 1G0	613-258-3411
Prince Edward, Hastings	Jody Bodnar	P.O. Box 470, Picton, K0K 2T0	613-476-3224
Northumberland, Peterborough	Dave Ridgeway	P.O. Box 340, Trenton, K8V 5R5	613-392-3527
Durham, Ontario, Victoria		234 King St. East, Bowmanville, L1C 1P5	416-623-3348
York County and Bradford Marsh Area	Matt Valk*	Bradford Muck Research Station, R.R. 1, Kettleby, L0G 1J0	416-775-3783
Simcoe, Dufferin, Grey	Ken Wilson	P.O. Box 69, Clarksburg, N0H 1J0	519-599-2042
Halton, North Wentworth, Peel	Joe Uyenaka	181 Main St., Milton, L9T 1N7	416-878-2314
Niagara Peninsula	Burke McNeil	Vineland Station, L0R 2E0	416-562-4142
	Ian Smith	Vineland Station, L0R 2E0	416-562-4142
Norfolk, Brant	Steve Rowe	P.O. Box 246, Simcoe, N3Y 4L1	519-426-7120
Oxford, Elgin	Keith Priest	P.O. Box 666, Woodstock, N4S 7Z5	519-537-6621
Lambton, Middlesex, Huron	John Gardner	195 Dufferin Ave., 4th Floor, London, N6A 1K7	519-434-6811
Essex	Clem Fisher Leslie Huffman	Research Station, Harrow, N0R 1G0	519-738-2251
Kent	Ed Tomecek	College of Agricultural Technology, Ridgetown, N0P 2C0	519-674-5456
Provincial Potato Specialist	Sam Squire	P.O. Box 370, Alliston, L0M 1A0	705-435-5521
Extension Pathologist	Craig Hunter	P.O. Box 246, Simcoe, N3Y 4L1	519-426-7120

**Horticultural Research Institute of Ontario Staff*

In the event of a problem arising in connection with special pests, spray mixtures or spraying, telephone or write to the Horticultural Crop Advisor serving your area.

PESTICIDES CONTROL FIELD OFFICES

Ontario Ministry of the Environment

COUNTRY	DISTRICT	TELEPHONE
Essex, Kent, Lambton	H.E. Collins, P.O. Box 726 435 Grand Ave. West, Chatham N7M 5L1	519-354-2150
Southwestern Region		
Elgin, Middlesex, Oxford	D.C. Morrow & W. Lampman 985 Adelaide Street South, London N6E 1V3	519-661-2200
Haldimand, Norfolk, Niagara, Hamilton, Wentworth	J. Percy, Ontario Government Building 119 King St. W., Hamilton L8N 3Z9	416-521-7640
Simcoe, Muskoka	W. Cowie, 12 Fairview Road, Barrie L4N 4P3	705-726-1730
West Central Region		
Dufferin, Wellington, Waterloo, Brant	R. Miller, Ont. Gov't. Bldg., 119 King St. W., Hamilton L8N 3Z9	416-521-7640
Bruce, Grey, Huron, Perth	B.T. Lobb, 20 King Street, P.O. Box 688 Ontario Ministry of Agriculture & Food Bldg., Clinton N0M 1L0	519-482-3428
Central Region		
Halton, Peel, York, Durham, Toronto	T. O'Neill & D. Trenholm, 150 Ferrand Drive Suite 700, Don Mills M3C 3C3	416-424-3000
Peterborough, Victoria, Haliburton, Northumberland	A.G. Carpentier, 139 George Street N. Peterborough, K9J 3G6	705-743-2972
Frontenac, Hastings, Lennox & Addington, Prince Edward, Leeds & Grenville	D.A. Raddon, 133 Dalton St. Box 890, Kingston K7Z 4X6	613-549-4000
Southeastern Region		
Prescott & Russell, Renfrew, Stormont, Dundas & Glengarry, Ottawa-Carleton, Lanark	R.P. Cameron 2378 Holly Lane, Suite 204, Ottawa K1V 7P1	613-521-3450
Manitoulin, Nipissing, Parry Sound, Sudbury	D.J. Mewett, Northgate Shopping Centre 1500 Fisher St., North Bay P1B 2H3	705-476-1001
Northeastern Region		
Cochrane, Timiskaming, Algoma	P. McCubbin, 199 Larch St., Sudbury P3E 5P9	705-675-4501 705-949-4640
Kenora, Rainy River, Thunder Bay	G.R. Gammond, Ontario Government Building Thunder Bay "F" P7E 6E3	807-475-1215
Head Office	Pesticides Control Section 135 St. Clair Avenue West, Suite 100 Toronto M4V 1P5	416-965-2401

PRECAUTIONS WITH ALL PESTICIDES

1. Always read the label before opening pesticide containers, and follow all precautions and directions.

2. Never smoke, chew tobacco or eat while handling or applying pesticides. **Do not** carry such items in clothes for spraying.

3. Always wear neoprene gloves to handle the concentrate, and when coming in contact with dilute spray i.e. cleaning nozzles, and pumps, and handling contaminated spray equipment.

4. Inhalation of spray droplets, dust or fumes should be avoided.

   Wear a respirator to reduce pesticide inhalation especially when handling dusty formulations or volatile concentrates. For gases a self-contained breathing apparatus may be required.

5. Wear freshly laundered clothes each day, including caps. Regularly wash gloves and boots.

   Avoid spilling pesticides on skin or clothing.

6. Avoid contamination of water supplies, wells, ponds, streams, etc. with pesticides when filling or flushing spray equipment. Never fill a sprayer directly from a stream, pond or well unless the unit is equipped with an anti-backflow device to prevent siphoning.

7. Keep a record of the common names of all pesticides handled and especially those listed as hazardous in this publication. This list should be known by members of your family in the event of an accident. You can use this book, see page 8.

IF ACCIDENTS OCCUR

1. If an accident occurs, remove contaminated clothing including under clothes immediately, and wash contaminated skin thoroughly with soap and water. Wash all clothing including caps, gloves and boots before reuse.

2. If clothing becomes wet with a pesticide, when spraying remove it immediately. When the spray operation is complete, remove all contaminated clothes including under clothes, have a bath or shower and put on freshly laundered clothing.

3. If symptoms of illness occur during or shortly after handling or applying a pesticide, get the patient to a hospital immediately. Take the list of common name chemicals with you to the hopital (see Emergency Procedures for Pesticide Poisoning).

4. Clean up any pesticide spills immediately. Use dry soil or other absorbent material to remove excess liquid. If the spill is major, contact the nearest office of the Pesticide Control Service for advice. (See list page 3)

FIRST-AID INFORMATION

The Occupational Health and Safety Division, Ministry of Labour, 400 University Avenue, Toronto, M7A 1T7, has physicians available for consultation on first-aid information and advice. They can be contacted:

Between 8:00 a.m. and 5:00 p.m. Monday to Friday.
Telephone (416) 965-3610.

During weekends, public holidays and non-office hours. Telephone (416) 965-1211 and ask for the "on-call" physician.

National Poison Centre — telephone (613) 992-0979
Health and Welfare, Canada
Ottawa

EMERGENCY PROCEDURES FOR PESTICIDE POISONING

If a pesticide is spilled onto clothing or parts of the body remove clothing including under-garments and wash skin and hair with water or soap and water if available. Flush eyes with plenty of water.

Should a person exhibit symptoms of poisoning such as weakness, slow heartbeat, incoordination, tremors, abdominal cramps, salivation, or blurred vision but is still conscious, seek medical help immediately by rushing the patient to the emergency ward of the nearest hospital. If the patient is unconscious call an ambulance.

Always know the common name of the chemical being used. Get this from the label or from the list on page 8.

RELATIVE HAZARD TO HUMANS OF PESTICIDES RECOMMENDED ON GREENHOUSE CROPS

Extreme and High Hazard

Wear a chemical cartridge respirator with a dual chemical cartridge suitable for the pesticide to be used for protection against most pesticides. It is recommended for outside use against light concentrations of pesticides. This type of respirator and cartridge should be used along with rubber or neoprene gloves, rubber boots and protective eye shields when handling or mixing any of the pesticides listed below. It is also worn when applying extremely toxic or highly toxic compounds outdoors.

Extreme Hazard

Dasanit (Fensulfothion)Methyl Bromide
Sulfotep
Temik (Aldicarb)
All Smokes. . .DDVP Parathion, Sulfotep, Termil, Nicotine Sulfate
Telone
Vorlex

Moderate Hazard

These pesticides are dangerous through inhalation, skin contact of if taken by mouth. A few grams can be fatal. Always wear protective clothing when mixing or applying these chemicals. Avoid mixing in windy areas and dispose of containers properly. Always change clothing and wash immediately after using these materials.

Diazinon	Meta Systox R (oxydemation methyl)
Lesan (Fenaminousulf)	Acti-Dione PM (cycloheximide)
Lindane	Pirimor (primicarb)

Thiodan (Endosulfan)

These pesticides are dangerous if handled carelessly. Caution is required to insure that they are not taken internally or allowed to contact the skin. Wear protective clothing, including respirator and goggles, when mixing or working with them in confined areas. Avoid breathing the vapors. Triple rinse and dispose of containers properly. Always change clothing and wash up immediately after using these materials.

Low Hazard

Pesticides listed in this calendar and not appearing on this list are less toxic, but should be handled with all precautions listed on the label. Even the most toxic pesticide can be used safely, if used properly, by following all directions and precautions listed on the label.

BLOOD TESTS FOR THOSE APPLYING PESTICIDES

Organophosphorus and carbamate pesticides are capable of inactivating and depressing the serum and red blood cholinesterase levels. If the activity of cholinesterase falls below a critical level, human poisoning can result as exhibited by fatigue, dizziness, nausea, trembling, blurred vision, difficulty in breathing and other symptoms. For those working outdoors and applying these groups of pesticides it is strongly recommended that cholinesterase levels be checked by your family doctor. To be of value the tests should be commenced prior to using these pesticides and not after applications have commenced since the normal level per individual can vary considerably making it difficult to assess the degree of suppression. In this publication the primary insecticides of concern are: Dasanit (Fensulfothion), Parathion, Sulfotep, Temik (Aldicarb), DDVP Smokes (Dichlorvos), Diazinon, Meta-Systox R (oxydemeton methyl) Pirimor (Pirimicarb).

PROTECTIVE CLOTHING WHEN USING PESTICIDES IN GREENHOUSES AND OTHER ENCLOSED AREAS

Respiratory Protection — Available Devices

Air-Purifying Devices — Canister Gas Masks

Canister gas masks have been used effectively for many years by greenhouse applicators for respiratory protection against certain gases, vapors and particulate matter which otherwise might be harmful to life or health.

From a practical standpoint, canister gas masks are generally suitable for ventilated areas not subject to rapid change, but should never be used in confined spaces where oxygen deficiency and high gas concentrations may occur.

Self-Contained Breathing Apparatus

Self-contained breathing apparatus approved by NIOSH (U.S. National Institute of Occupational Safety and Health) is the only apparatus recommended for respiratory protection in enclosed places where oxygen-deficiency with high gas concentrations occur.

Working Conditions

High Concentrations

(a) Use only a self-contained breathing apparatus e.g. Scott, Air Pak

(b) High concentration of toxic gases, vapors or particulate matter can be produced when dispensing extremely or highly toxic pesticides such as parathion, nicotine and naled (Dibrom):

(i) through fogging machines
(ii) by means of smoke bombs
(iii) as spray applications

In such instances self-contained breathing apparatus is recommended.

Low Concentrations

Canister gas masks may be used when the ambient air contains low concentrations of toxic gases, vapors or particulate matter derived from soil-drench, granular, dust or foliar spray applications. Pesticides applied in such manner are usually of moderate to low toxicity. The exceptions include aldicarb (Temik 10G) and fensulfothion (Dasanit 15G) but the wearing of canister gas masks provides protection.

Contact your safety supply company for the proper canister selection.

Other Clothing

When measuring, mixing and applying pesticides, wear neoprene or rubber gloves, rubber boots, a protective apron or coveralls, hat, and protective eyeshields or a full-face mask.

METHYL BROMIDE AND INSECTICIDE SMOKES

A permit issued by the Ontario Ministry of the Environment is necessary to use methyl bromide (MC-2 and MB-C_2). To apply for a permit contact:

Licensing Unit
Environmental Approvals and Land
Use Planning Branch
9th Floor
135 St. Clair Avenue West
Toronto, Ontario
M4V 1P5
Telephone:
(416) 963-3830

When using methyl bromide or insecticide smoke generators, suitable protective clothing must be worn. After treatment, the greenhouse must be barricaded and warning signs posted. In general, smokes are especially useful for small greenhouses of 930 m^2 or less. Smoke applications are not satisfactory for spot treatment.

For methyl bromide, soil temperature should be above 15°C.

REENTRY TO TREATED AREAS

Pesticide poisoning may occur where workers enter greenhouses too soon after pesticides have been applied. Such poisoning can result from handling treated plants or from inhalation of pesticide vapors. Examine the pesticide label for precautionary statements on working in treated areas.

For all materials in the form of smokes, aerosols or vapors, lock and post the greenhouse and ventilate to ensure safety before working in the greenhouse. The minimum interval between application and reentry for these products is 12 hours.

The pesticides listed below are those for which a specified minimum interval must be observed from the time of application to the time of working in the crop.

Minimum reentry time of 48 hours for

Dasanit (Fensulfothion)
Temik (Aldicarb)

The specified reentry period refers to the treated bed, ground bed, or bench specifically treated with these materials and not to the greenhouse range as a whole.

Minimum reentry time of 72 hours for

Telone
Telone II
Vorlex

Use a respirator approved for 1,3-dichloropropene if reentry is necessary to the greenhouse range.

Storage of Pesticides

1. General Storage:

The Ontario Pesticides Act and Regulation 751 require that all pesticides be kept out of the reach of children, irresponsible persons, pets and livestock. They should be stored in a locked facility away from food for humans, and feed for animals. Herbicides should be stored separately from other pesticides to avoid possible contamination.

Special Storage:

Schedule 1, 2 and 5 pesticides must be stored in a storage facility which is ventilated to the outside atmosphere. A placard bearing the words **"Chemical Storage Warning — Authorized Persons Only"** in block capitals must be affixed to the outside of each entrance. Entry to the storage facility should only be made by the person responsible for the pesticide, or with his permission.

2. **Always store pesticides in original containers and keep them tightly closed. Never put pesticides in unmarked containers.** See also OMAF Factsheet, *Farm Storage of Pesticides*, Agdex 607.

3. Post pesticide storage areas with proper notices.

4. In areas where flooding has been a frequent occurrence, fertilizers and pesticides must be stored above the known high water mark to avoid contamination of the flood waters. Contamination of water by these chemicals can and has led to serious health problems, affecting humans, domestic animals as well as fish and wildlife.

Disposal of Pesticide Containers and Contaminated Material

1. Containers from pesticide packages, and any paper or other material used to clean up spills, should be buried or burned. Make sure that people and animals are kept away from the smoke, and the smoke is not directed toward buildings, highways, roads, or outdoor public areas.

2. Un-rinsed containers can contain as much as 3% of the original formulation. If this amount of toxic pesticide is discarded with the drum it could be dangerous to other people handling it, or to the environment (For example, your water supply). Failure to rinse is also wasteful — why not use that 3% for the purpose for which it was purchased, i.e., to control the pest!

   Rinse all empty metal or glass containers three times with water and add washings to the spray tank. Or, use a rinsing device. These rinsers can be used to puncture the bottom of a metal or plastic drum, and to rinse the residual left in the container directly into the spray tank. This procedure takes less than a minute and results in a rinse container. The rinsed containers may be crushed, buried and covered by at least 50 cm of soil, away from any watercourse or water table.

SHELF LIFE OF PESTICIDES

Most pesticides, if stored in a cool (not freezing), dry place, will remain effective for 2 years or more.

It is a good idea to mark the date of purchase on the package.

The following is only a guide to check effectiveness of pesticides that have been stored.

Formulation	Discard material if:
Dust	excessive lumping is evident;
Emulsifiable and spray concentrate	the solution does not turn milky when mixed with water or if the mixture separates or if a sludge forms;
Granulars	excessive lumping or caking is evident, and it does not run freely;
Oil sprays	a milky solution does not form when mixed with water;
Wettable powders	material is lumpy and powder will not mix with water.

TYPES OF APPLICATION EQUIPMENT

1. **Spraying** is one of the most widely used and effective methods of applying pesticides. The nozzles should be clean and pressure maintained to achieve a fine spray which will result in uniform coverage when the mixture is applied up to the point of runoff. Complete coverage is the objective; be sure to spray thoroughly both lower and upper leaf surfaces.

2. **Fogs** are produced by several kinds of machines. These machines all use heat from different sources to vaporize the pesticide. Fogging can be a very efficient method of pesticide application provided the operator follows basic instructions.

3. **Granular Application.** Several types of applicators are available for applying granular pesticides. Commonly used devices are shaker bottles and cyclone spreaders. Be sure the applicator does not grind or fracture the granules.

4. **Dusters** are used to a very limited extent as it is difficult to get good coverage on the underside of foliage and the dust is considered unsightly on the foliage at time of sale.

5. **Smokes** are a very simple but effective means of pesticide application. There is no equipment involved; containers are simply placed on the path and lighted. Growers should be cautioned against using smokes in very old, loose greenhouses or during high winds.

WETTING AGENTS

In the following discussion, the term "wetting agent" will be used to include spreaders, stickers and surfactants, although these terms do have slightly different meanings.

A wetting agent is used to allow the pesticide to spread evenly over the foliage. Most pesticides are formulated with a wetting agent in them, but in some cases, due to the temperature of the water or air, hardness of the water, type of leaf surface, stage of plant growth and/or the type of formulation, the amount may not be adequate. Consult the label for specific recommendations.

A simple method of determining if the amount of wetting agent present is sufficient is to spray about 3 metres of bed area. Examine to see if both the upper and lower surfaces of leaves of different stages of growth are uniformly wetted with a light film of the spray.

If not, add 125 mL of spreader per 1000L of spray. Spray another 3 metres of bed and reexamine. Continue until the wetting is satisfactory.

Wetting agents help the spray solution to "wet" powdery mildew mycelium and improve control. The use of an excessive amount of wetting agent can result in plant damage, excessive foaming, which will cause pumping problems of "runoff" resulting in poor control.

RECOMMENDATIONS RE SPRAY-TANK MIXTURES IN ALKALINE WATER

Because many pesticides are susceptible to alkaline water, it is recommended that pesticides diluted with alkaline water be used immediately.

However, "spray immediately" is not always possible owing to unexpected reasons. Any delay in applying spray mixtures will result in pesticide loss due to degradation[1] and possibly a corresponding decrease in control.

To avoid this possibility, it is recommended that alkaline water be neutralized before adding any pesticides. Dissolve potassium or ammonium dihydrogen phosphate at the rate of 50 g per 100 litres of water, and then add pesticides.

The phosphate is not always necessary, but this practice is a sort of insurance. The cost of the phosphate is substantially less than that of the pesticides. Also, the added phosphate will be available as a foliar nutrient.

Occasionally water-soluble fertilizers are used with pesticides as a tank mixture. This practice is not encouraged because most of the water-soluble fertilizers are strongly alkaline. If these fertilizers are used, the amount of phosphate recommended above is not sufficient to neutralize the water.

---

[1] *The rate of degradation is dependent on the pesticide, the concentration of pesticide in the tank (dilution factor), and temperature.*

PESTICIDE REGULATIONS

An agriculturist may be briefly defined as a person who farms a minimum of 11 contiguous acres or has a minimum farm income of $12,000. At the present time an agriculturist can buy and use pesticides in schedule 2, 3, 4, 5 and 6.

A license to purchase and use methyl bromide can be obtained from your local Pesticides Control Officer or from:
Licensing Unit
Environmental Approvals and Land
Use Planning Branch
9th Floor
135 St. Clair Avenue West
Toronto, Ontario
M4V 1P5

Telephone: (416) 963-3830

PREVENTIVE vs ERADICANT PROGRAMS

The old adage "an ounce of prevention is worth a pound of cure" is best applied to a pest-control program. Failure to conduct a timely preventive program often results in total crop failure because the product is either not marketable or is greatly reduced in market value. The expenditure for a small amount of pesticide applied on a regular basis is the best protection against needless crop failures. In short, you are gambling a few pennies of prevention against many dollars of last-minute eradication and the possibility of total crop failure.

The use of yellow "sticky" boards can be useful in attracting insects in the greenhouse in order that identification and estimates of numbers can occur.

PESTICIDE RESISTANCE

Occasionally, apparent poor results may be obtained after applying pesticides. Some reasons may be as follows: improper dilution caused by not checking the label directions, poor coverage due to poor application technique or lack of a wetting agent, resistance buildup due to continuous use of one chemical. Organisms which exhibit reduced sensitivity to a pesticide are called resistant. Many of the pesticides recommended have a very specific mechanism of action, that is, they act on a single system or site in the organism. These materials should not be used continuously and repeatedly in a season-long program since this will increase the chances of the development of pest resistance. Examples of these types of compounds are Benlate and Ambush.

Resistance can be delayed or prevented by the early use of control programs designed to avoid continuous or long-term exposure to a pesticide. To help overcome a resistance problem, occasionally alternate with another recommended material from a different chemical family.

PESTICIDE TOXICITY

Common Name	(Trade Name)	LD_{50} (mg a.i./kg)*	Chemical Family**	Ontario Schedule Number
Insecticides and Miticides				
Acephate	(Orthene)	866	OP	2
Aldicarb	(Temik)	1	Carbamate	5
Bacillus thuringiensis	(Dipel) (Thuricide)	non-toxic	Biological	3
Bendiocarb	(Trumpet)	179	Carbamate	2
Carbaryl	(Sevin)	560	Carbamate	3
Chlorpyrifos	(Lorsban) (Dursban)	135	OP	2
Cyhexatin	(Plictran)	540	Organotin	3
Demeton	(Systox)	2.5	OP	5
Diazinon	(Diazinon)	300	OP	2
Dichlorvos	(DDVP) Smoke	80	OP	3
Dicofol	(Kelthane)	684	OC	2
Dienochlor	(Pentac)	3160	OC	3
Dimethoate	(Cygon)	215	OP	2
Disulfoton	(Di-Syston)	2.6	OP	2
Endosulfan	(Thiodan)	110	OC	2
Fenbutatin oxide	(Vendex)	2631	Organotin	3
Lindane	(Lindane)	88	OC	2
Malathion	(Malathion)	1400	OP	3
Mevinphos	(Phosdrin)	5	OP	
Naled	(Dibrom)	430	OP	2
Nicotine	(Nicotine) Smoke	50	Botanical	2
Oxamyl	(Vydate)	5	Carbamate	
Oxydemeton-methyl	(Metasystox-R)	75	OP	2
Oxythioquinox	(Morestan)	2500	Carbamate	3
Parathion	(Parathion) Smoke	3.6	OP	5
Permethrin	(Ambush) (Pounce)	4000+	Syn. Pyr.	3
Pirimicarb	(Pirimor)	147	Carbamate	2
Pyrazophos	(Afugan)	500	OP	1
Sulfotep	(Sulfotep) 103 Smoke	10	OP	5
Tetradifon	(Tedion) Smoke	14700+	OC	3
Trichlorfon	(Dylox)	560	OP	3
Fungicides				
Benomyl	(Benlate)	10000+	Ben.	3
Captan	(Captan)	9000	Ph.	2
Carboxin	(Vitavax)	3820	Ox.	2
Chlorothalonil	(Exotherm Termil) (Daconil 2787)	10000+	Arom.	
Copper Sulphate			Copper	
Cycloheximide	(Acti-dione P.M.)	2.5	Antibiotic	3
Dazomet	(Basamid) (Mylone)			3
Dichloran	(Botran)	10000+	Dicarb.	3
Dinocap	(Karathane)	1190	Dinitro	2
Dodemorphace-tate	(Meltatox)	4180	Morph.	3
Etridiazole	(Truban)	1077	Thia.	3
Fenaminosulf	(Lesan)	60	Arom.	2
Ferbam	(Ferbam)	17000+	Dithio.	3
Fixed Copper	(Fixed Copper) (Tricop) (Basicop) (Kocide 101)			
Folpet	(Phaltan)	10000+	Ph.	2
Formaldehyde	(Formalin) (Standard F) (Tamblyn F)			
Iprodione	(Rovral)	3500	Dicarb.	3
Oxine benzoate	(No-Damp)		Arom.	3
Maneb	(Manzated) (Dithane M22)	6750	Dithio	
Mancozeb	(Manzate 200)		Dithio	
Metalaxyl	Subdue 2G	669	Arom.	2
Quintozene	(Quintozene)	30000	Arom.	3
Streptomycin	(Agri-mycin)	9000	Antibiotic	3
Thiophanate methyl	(Easout)	10000+	Ben.	3
Triforine	(Funginex)	6000+	EBI	3
Zineb	(Zineb)	5000+	Dithio.	3

**The relative toxicity of a pesticide may be referred to as its LD_{50}. This is the amount of the active ingredient (a.i.) of the chemical in milligrams used per kilogram of test animal (usually female rats) that kills 50% of the test animals. This is commonly measured as the Acute Oral LD_{50} (above) which refers to the chemical ingested through the mouth or nose. Dermal LD_{50} figures, or skin penetration, are also available. The higher the LD_{50} figure the less toxic the product is to humans.*
Note: Many pesticides of low acute toxicity are being shown to cause long-term effects in laboratory animals. Users are therefore warned that these could be detrimental to your health. Exposure should be reduced to a minimum by wearing protective clothing. Gloves, goggles and long-sleeved shirt are particularly effective.

***OP = Organophosphorus, OC = Organochlorine, IGR = Insect growth regulator, Syn. Pyr. = Synthetic pyrethroid*

Ben. — benzimidazole
Ph. — phthalimide
Ox. — oxithiin
Dicarb. — dicarboximide
Dinitro — dinitrophenol
Morph. — morphactin
EBI — ergosterol biosynthesis inhibitor
Thia. — thiadiazole
Arom. — aromatic hydrocarbon
Dithio — dithio carbamate

CLEANLINESS AND SANITATION

Sanitation is the first step in any pest-control program. If a source of infection is constantly present, pest-control programs will be expensive and frustrating.

(a) Remove dead and dying leaves and flowers.

(b) Keep walks and the surface of beds clean.

(c) Control weeds in and outside greenhouses.

(d) Hang up the ends of hoses.

When bringing new stock into the greenhouse, check carefully for possible infestations.

A five meter strip of carefully maintained lawn around and between greenhouses will decrease the danger of invasion from insects and diseases that may otherwise harbor on adjacent weed growth.

In vegetable greenhouses, there are usually a few weeks, or months when the houses are empty between crops. To prevent disease organisms from carrying over on the empty structures, heating pipes, walks, etc., spray with:
(1) 10% sodium hypochlorite solution — 1 part hypochlorite to 9 parts of water, or
(2) 37% formalin solution — 30 litres to 1000 litres of water.
Note: both (1) and (2) are toxic to plants.

Immediately after spraying, close the greenhouse for 3 or 4 days, then ventilate. CAUTION: Wear a respirator when spraying with formaldehyde, or sodium hypochlorite. Vegetable growers are also advised to:
(1) Remove, and burn or bury all plant refuse as soon as the crop is terminated. Never leave it in piles near the greenhouse area.
(2) Avoid overwintering garden or houseplants in the greenhouses. Pests will also be maintained, for an early invasion of the next crop.

Cleanliness in itself will not control pest problems but is a basic part of any control program.

BENCH AND EQUIPMENT STERILIZATION

Bench and equipment sterilization are a part of every greenhouse management program. To help eliminate disease and insect pests, all production equipment should be as clean as possible. Tools, potting benches, carts, walkways and growing benches should be sterilized between crops.

For a general greenhouse cleanup, use a commercial disinfectant such as a chloride bleach, e.g., Javex at 1 pt 6% bleach in 9 parts water. Ventilate the work area after treatment. Bleach is toxic to plants.

Remember also to sterilize automatic watering systems, everything in the propagating area and to clean your hands between crops or houses. If available, a steam hose is ideal to clean tools, wheelbarrows, etc.

WOOD PRESERVATIVES

Only copper napthanate is recommended as a safe wood preservative for greenhouse use. Allow at least a week to elapse before placing plants on or near freshly treated wood. Some injury has occurred on poinsettias with copper napthanate. Two commonly available wood preservatives, creosote and pentachlorophenol, are excellent materials **but** can be extremely injurious to crops. Both the fumes and direct contact with plants will cause the damage. Therefore, do not use these materials around or in a greenhouse. Wolmanized lumber is recommended for greenhouse use.

SOIL PASTEURIZATION

Greenhouse and field soils contain weed seeds, insects, bacteria and fungi which may be harmful to the plants to be grown. This includes potting mixes and their components, unless guaranteed sterilized or pasteurized by the manufacturer. Soil and potting mixes can be pasteurized to eliminate these harmful organisms. Ideally, this is accomplished without injuring beneficial soil organisms.

Soil should be in fine tilth to allow rapid, uniform penetration of the steam fumigant. Soil should be free from clods, large lumps and undecomposed crop remains.

The following chart gives an idea of the time-temperature relationships necessary to destroy undesirable organisms.

Weeds (most)	70°-80° C for 15 min
Insects & Mites	60°-71° C for 20 min
Bacteria (most)	60° C for 10 min
Fusarium	57° C for 30 min
Botrytis	55° C for 15 min
Nematodes	55° C for 15 min
Rhizoctonia	52° C for 30 min
Sclerotinia	50° C for 5 min
Pythium	46° C for 40 min

As can be seen from the chart, most organisms of concern to growers can be eliminated under ideal conditions of 60° C for 30 minutes. Above 82° C beneficial soil organisms start to be destroyed. If the soil is heated at too high a temperature for too long a time, it becomes sterile and subject to a greater degree of infection than previously, simply because all organisms have been destroyed. There are many other undesirable effects of over-steaming including:

(a) excessive ammonia release

(b) manganese toxicity

(c) higher total salts levels

(d) destruction of organic matter.

Methods

1. Steam is the most common source of heat for pasteurization today. Steam is fast, efficient, effective and as economical as any system. There are different ways of handling steam, depending upon the type of crop being grown. When pasteurizing soil for vegetable seedlings or potted plants, growers find it is most efficient to inject steam into the bottom of a wagon or old truck body. After cooling, the pasteurized soil can be moved as a mass to the area in which it will be used. Growers of cut flower or vegetable crops follow two main techniques. If their ground beds are drained with agricultural tile (top of tile 40 cm below the surface and rows on 60 cm centres), it becomes a very simple matter to inject steam into these tiles and very effectively pasteurize the soil to the sides and above them. If tiles are not installed, then the steam is injected directly under a tarp covering the bed through either a canvas hose or a perforated, flexible pastic field tile for even distribution.

2. Aerated steam is being used more widely today. In this system, live steam is mixed with air in a chamber and the mixture (at 70° C) is used to pasteurize soil. The lower steam temperatures allow the soil to be pasteurized and avoid any of the hazards of oversteaming. Unless there are specific problems, soil temperatures of 70° C are adequate for most insect and disease problems.

3. Electric soil pasteurizers are useful where small volumes of soil are used and no other method is available. Over-cooking the soil can occur very easily because in order for the temperature between the finned heat source to reach 82° C, the fins themselves must be at a higher temperature.

4. The use of chemical fumigants such as Basamid, Methyl Bromide, Telone II, Vapam and Vorlex as a method of soil pasteurizing has become more popular with the high cost of steaming. Each of the fumigants mentioned has a specific rate and activity against soil-borne insects, diseases, nematodes and weeds. Crops in adjoining beds or benches may have to be guarded. For fumigation of soil in bulk piles or stacked flats, pressurized cans of methyl bromide-chloropicrin (MB-C_2, Bromogas) can be injected. Soil in bulk piles or stacked flats can be effectively fumigated, if covered by an air tight plastic cover by injecting 98% methyl bromide-2% chloropicrin mixture from pressurized cans (MB-C_2, Bromogas) at 0.3 kg./M^3. (See licensing requirement, p. 00). Fumigants listed below are effective as preplanting treatments for greenhouse soil beds. **Amounts as shown are for 100 square meters.**

   1) Control of nematodes (only).
   Telone II - 2.0 L
   2) Vorlex - 2.5 L

   Control fungi, nematodes, insects and some bacteria
   Basamid (granular) 3.25-5 kg. incorporated thoroughly to a depth of 15-23 cm.
   Vapam (liquid) 10 L
   Vorlex (liquid) 6 L
   Methyl bromide-chloropicrin.
   1. pressurized cans 98%-2% — 7.5-10 kg.
   2. Injectable 68%-31.8% — 2.5-3.65 kg.
   Notes:
   I. See Cautions on Methyl bromide — page 6

   II. The bromine residue that lingers in the soil after using Methyl Bromide may reduce the germination of and/or growth of salvia, dianthus, ageratum, alyssum, antirrhinum, aster, calendula, celosia, chrysanthemum, cleome, coleus, coreopsis, dahlia, digitalis, godetia, helichrysum, iberis, lobelia, matricaria, myosotis, nemesia, nierembergia, portulaca, salpiglossis, verbena, viola and vinca.

   III. Do not use methyl bromide prior to planting a lettuce crop.

SOIL DRENCHES

Soil drenches are not meant to replace a thorough pasteurization program in the greenhouse. They are useful in preventing recontamination or as an eradicant to eliminate pathogens in the soil or basal parts of the plant.

Some drenches are taken up by the roots of the plant from the soil. In this case, the drenches are systemic and the whole plant is effectively treated against pests. As a general rule, apply 12 L of drench per m^2 of bench area or 300 mL of drench per 15 cm pot. Follow the manufacturer's directions carefully.

COMPATIBILITY OF PESTICIDES

The pesticides recommended in this publication are for individual application to the crop. Before mixing pesticides, read the product label carefully for compatibility statements and contact the supplier.

Avoid mixing EC formulations. Herbicides should never be mixed with fungicides and insecticides. Apply with spray equipment reserved for herbicide use only.

TEMIK 10G

Temik 10G is a highly toxic pesticide that must be used with caution. It is a granular product that provides systemic control of certain insects and mites. The Temik granules should be applied evenly at the rate of 550 g/100 m^2 of plant bed or closely packed pots. The registered crops Poinsettias and Chrysanthemums should be established at least 3 weeks before the first application. Use an applicator that does not grind the granules such as the Ortho Whirlybird. Do not apply Temik 10G during the hot time of the day as perspiration will cause the Temik to be released if kernels land on your body. Wear a respirator mask, water-resistant clothing, goggles and rubber gloves during application and while filling or cleaning the equipment. After application, water the plants thoroughly and wash off any granules adhering to the foliage.

If the pests reappear, a second application may be necessary but should **not** be applied to potted plants within 4 weeks of sale. Do not plant food crops in soil previously treated for at least 1 year.

Ortho Whirlybird

After application, wash hands and face before eating or smoking. After work, wash entire body with soap and water. Do not work with treated plants for 48 hours.
Temik 10G must *never* be used on soils that will be planted to greenhouse vegetables (check label).

WEED CONTROL

Cultivation and hand weeding are still the most practical methods for controlling weeds in greenhouses. However, the use of some of the methods mentioned below may be useful in reducing the amount of labor necessary to keep weeds under control.

Steam The use of steam to pasteurize soil will kill weeds and most weed seeds if the soil temperature can be held at 70°-80° C for 15 minutes. Weed seeds in the outer layer of soil which has been at a lower temperature, and weed seeds with hard seed coats may not be killed.

Soil Fumigation Metam (VAPAM), dazomet (MYLONE, BASAMID), and VORLEX break down in the soil and produce a gas which kills nematodes, most weed seeds, organisms which cause "damping off" and other plant diseases. They are, therefore, useful in treating seedbeds and potting soil. Methyl bromide is a liquid which forms a poisonous gas when released from its container. It should be used under a gas-proof cover (usually plastic). This chemical is so poisonous to man and livestock that only experienced operators should attempt to use it. The use of Methyl Bromide is subject to the Pesticides Act (1973) and Regulations which requires that a permit be obtained from the local Pesticides Control Officer of the Ontario Ministry of the Environment each time it is to be used.

Herbicides OMAF Publication 75, *Guide to Chemical Weed Control* contains information on herbicides which are registered for use in Ontario. The treatments listed in the publication are based on extensive field trials and observations on farms. **Unless specifically recommended, herbicides should not be used in cold frames or greenhouses.** Damage to plants has occurred when hormone-like herbicides (2, 4-D, mecoprop, etc.) have been used in or near greenhouses, when atrazine has been used to control weeds under benches, and when sulfallate (VEGEDEX) has been used in cold frames. A copy of Publication 75 is available at any OMAF office or from your Extension Horticulturist. The information on chemicals, safety precautions and calibration, care and use of sprayers should be read carefully.

Paraquat (GRAMOXONE), diquat (REGLONE) or a mixture of both may be used at 0.55-1.10 kg/ha (active), or 3 mL of product per litre per 100 m^2 to kill emerged weeds in walks and under benches. These chemicals act as a "chemical mower" and do not leave a harmful residue in the soil. If applied as a spray, the pressure should be kept low (35-125 kPa) as any spray droplets which land on greenhouse plants will damage the plants. A plastic dribble bar is available which can be fitted to a watering can. The spray produced is coarse and easy to control.

Activated Charcoal Where unwanted pesticide residues remain in soil, an appliction of activated charcoal can reduce the problem. The rate will vary depending on the type of chemical contaminant and its concentration. A usual range is 0.5 to 1.5 kg/100 m^2.

READ THE LABEL BEFORE USING

ACIDITY AND ALKALINITY

Soil pH The term pH represents the degree of acidity or alkalinity of a solution (or soil). It is measured on a scale of 0-14. A pH of 7 is neutral; values below 7 are called acid (sour), and those above are alkaline.

The pH is a very important characteristic of soil as it influences the solubility and, thus, the availability of nutrients. Moreover, it influences indirectly the colonization of certain pathogens in the soil which may be harmful to plants.

Generally, a pH between 6.0 and 7.0 is an acceptable range for soil mixes or soil-grown crops. Azaleas and gardenias are exceptions to this rule while it is optional for hydrangeas and hyacinths. The pH of a soil can change due to many different reasons, e.g., continuous use of certain fertilizers, pH of irrigation water, type of soil amendments, etc. A regular check of soil pH, therefore, can be very helpful.

For soilless mixes with more than 50% organic material, the pH for optimal nutrient availability is between 5.0 and 6.0.

Any correction of the soil pH can be best managed at the time of soil preparation prior to planting. Limestone (dolomitic or calcitic) is usually used to increase the pH to the desired level. For a bench crop (loamy soil) the following rule of thumb may be used. To increase the pH with 0.1 unit, use 4.8 kg of limestone per 100 m^2. For a soil with a higher clay content or a higher organic matter content the recommended amount can be increased by about 25%. Two to three weeks after application, the soil pH sould be checked to see whether the desired pH level is attained. It may be noted that the finer the limestone, the quicker the reaction with the soil.

The rate of change is also affected by temperature, moisture and aeration conditions of the soil. Changes will occur most rapidly when soils or soilless media are warm, moist and well aerated.

The use of hydrated lime in greenhouses has some severe drawbacks as it reacts very quickly and actively. Proper distribution of the material throughout the soil mixture is difficult and the use of this material is very limited.

For potting mixtures, the amount of limestone to be added depends on the type and ratio of the ingredients. Acidic are

sphagnum peatmoss (pH 3.5 to 4.5) and bark (pH = 4.0) while alkaline materials are often the baked clay types such as Turface, Haydite and Crackpot or Sand. The amount of limestone to neutralize sphagnum peatmoss from a pH of 3.5 to 5.5 is about 6-7 kg per m^3 of loose peatmoss. The addition of clay additives with a high pH should reduce this rate of limestone. A check on the pH of the mix should be made after preparation, but before planting.

There are different methods to lower the pH in the growing mixture. Acid peatmoss, ground sulfur, iron sulfate and/or aluminum sulfate can be used as an amendment to a bench crop. Rates of application according to Cornell recommendations are listed in the table below.

Materials	**g/100 m^2 To Lower pH 1/2-1 Unit[1]**	**Rate of pH Change**
Finely Ground Sulfur	2.5 kg	slow
Aluminum Sulfate	15 kg	rapid
Iron Sulfate	15 kg	moderate

[1] Rates are for light to medium soils. For heavier soils with more organic matter, increase rate by one third. The rates per m^3 of potting soils are one half the recommended rates from above.

Low calcium and magnesium levels are becoming apparent in many greenhouse soils that have been in production for many years. The reason is that water soluble fertilizers now in use lack calcium and magnesium because of the high phosphorus content. If the pH has dropped, the use of dolomitic limestone is recommended as a source of calcium and magnesium. However, if the pH has remained within the desired range, the use of gypsum (calcium sulphate) at the rates of 10-50 kg/100m^2 will supply calcium and Epsom Salts (magnesium sulphate) at rates of 5-15 kg/100m^2 will supply magnesium.

Water pH The addition of an acid to the irrigation water on a continuous basis is possible, as well. Phosphoric acid (85%) is often used. Recommended additions vary between 6 and 18 mL per 100 L of water depending on the characteristics of the water. An exact level can be obtained by trial and error. Your Extension Horticulturist should be consulted if in doubt. The pH of the irrigation water should preferably not be below the 5.0 level.

Nitric acid and sulphuric acid can also be used but are more hazardous to use from a safety point of view as well as the amount of acid has to be added more accurately than phosphoric acid.

For making concentrates, ACID MUST BE ADDED TO WATER.

A safe, weak acid is ammonium dihydrogen phosphate. 50 gms per 100 L of irrigation water will lower the pH of most irrigation waters from 7.5 to 6.5-6.8.

MAJOR GREENHOUSE PESTS

Aphids

These insects are often referred to as plant lice. They are small with long legs and antennae, and have a pair of tube-like structures called cornicles projecting from the posterior end. Several species may occur in the greenhouse, each having a specific color pattern ranging from black, grey, red and yellow or green. Adult aphids may be winged or wingless. Aphids are found in colonies on new buds and under leaves near the veins. Female aphids give birth to living young and these offspring can reproduce within 7-10 days. One aphid can give birth to 60 to 100 young over a 20-day period. Populations can build up very rapidly. It is important to inspect new foliage continuously for the presence of aphids to prevent large infestations. Aphids pierce plant tissue with their mouthparts and suck out the sap, causing deformed leaves and flowers. They also produce a sticky substance called honeydew which promotes the development of black, sooty mold fungus. Some aphids are capable of transmitting plant viruses which may result in yellowing or distorted leaf tissue. Fumigation may be more effective and less phytotoxic to plants when infestations occur in the blossom stage. Systemic insecticides applied as foliar sprays or as drenches and granules are highly effective and preferred by most growers.

Fungus Gnats

Fungus gnats or sciarid flies are becoming a serious problem because of the greater use of soilless mixes that have a high organic matter or peatmoss content. The grey-black colored adult fly is about 4 mm in length with long legs, thread-like antennae and large compound eyes which meet abouve the base of the antennae. The adult is a weak flier and is frequently observed resting on the media surface in the pot. Each feamale (lifespan of 10 days) lays approx. 150 oval, white eggs in the organic matter of the media. They hatch in 2 to 7 days, depending on the temperature, to produce white larvae 4 to 6 mm long. The larvae have 12 abdominal segments and a shiny black head. They feed on decaying organic matter and occasionally on young roots of plants. Root feeding promotes various root rot organisms. The larvae spin pupil cases and remain inmobile in the soil for 4-6 days, after which adult flies emerge. The sciarid becomes more active at warmer tempreatures. The life cycle can be completed in 21 days at 24°C compared with 38 days at 16°C. Sanitation in the greenhouse as well as outside is very important. Avoid overwatering. Soil drenches and granular pesticides will give effective control.

Chrysanthemum Leafminer

The serpentine leafminer, *Liriomyza trifolii*, is one of the major pests of greenhouse floriculture in Ontario. The adult leafminer fly is small (approx. 3 mm long) with black and yellow markings. Adults become active at sunrise; females feed on soft succulent chyrsanthemum leaves by piercing the surface with their ovipositor and then lapping the liquid exuding from the leaf. After a pre-egg-laying period of 12-24 hours after emergence from pupae, female flies lay an average of 17 eggs per day, or approximately 250 eggs during their lifetime (approx. 30 days). Eggs are laid in about one out of seven leaf punctures (''stipples''). The optimal temperature for leafminer development is 30°C. At temperatures above or below 30°C, the egg production per female declines considerably. After 2-4 days, eggs hatch and larvae start feeding (mining) in the leaf tissue. The larvae mature in 4-7 days (temperature dependent) in the summer and then cut a hole in the leaf surface and drop to the soil. Within a few hours pupation takes place in the soil or on the soil surface and these pupae remain there for 7-14 days (tempreature dependent) in the summer. From the pupae, a new generation of adult flies emerges. Of course, within any greenhouse there is a considerable overlapping of stages of the insect's life cycle.

Based on lab studies the complete life cycle (egg to adult) is as short as 14 days at 30°C and increases to 24 days at 20°C and 65 days at 14°C. It has been reported that at low soil temperatures (10-12°C) the pupae may remain in the soil for up to 90 days. This fact may account for the winter survival of the leafminer around the inside perimeter of the greenhouse, even though no leafminers are evident.

More than 50 hosts other than chrysanthemum have been identified as alternate hosts for leafminer including many vegetables and many common weeds. Our recommended leafminer control strategy involves a wise use of: (1) Cultural controls (steaming, weed control, sanitation, etc.), (2) Population monitoring (using yellow sticky boards); and (3) Chemical controls. This insect's resistance to most insecticides is a major concern. Good pesticide coverage of the crop (2000 L per hectare) and rotation of pesticide classes is essential. There are no chemical controls for the egg or pupal stage of leafminer at present. The only effective treatments at present are systemic insecticides to kill larvae and contact sprays to kill adults.

Mealybugs

Two distinct groups of mealybugs may be found in greenhouses. The more commonly encountered **foliage-feeding mealybugs** are white, wax-covered, scale-like insects with piercing mouthparts which remove plant sap. Mealybugs produce large amounts of honeydew. The females (1 to 3 mm long) lay large numbers of eggs in masses of wax. From these eggs hatch (in 5-10 days) active immature mealybugs called crawlers. The nymphs require 6 to 8 weeks to mature to reproductive adults. Damage is caused by the removal of plant sap, the growth of black, sooty mold fungus on the honeydew and the unsightly appearance of the waxy secretions. Mealybugs are a serious greenhouse pest because of the rapid spread of large numbers of crawlers and their ability to exist under bud scales and within leaf axils. Males, present in low numbers, are small, winged insects.

Occasionally, **root feeding** or **subterranean mealybugs** are found within masses of wax on the roots of wilting or yellowed plants. These insects are much like those described above except that they secrete less wax over their bodies. Again the crawler stage may spread to other plants through contaminated equipment or water leaching through pots. Most infestations result from introduced material that was contaminated. Inspect all plant materials entering the greenhouse carefully for the presence of mealybugs. Systemic granular and drench insecticides are the most effective for controlling these insects.

Mites

Mites are generally small organisms and, in contrast to insects, are wingless with oval bodies and 8 short legs. The adult females lay microscopic, spherical eggs which produce the immature nymphs. They have piercing-sucking mouthparts which remove sap from plant tissue giving leaves a dried, whitish appearance or cause new growth to be distorted. Two of the more common species will be mentioned here.

Cyclamen mite

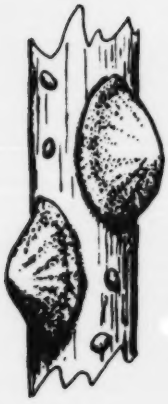
The cyclamen mite is microscopic in size, being no more than .25 mm in length. It cannot be seen without magnification. The hind pair of legs of the female are thread-like while those of the male are pincer-like. The pale brown female mite deposits approximately 100 eggs, 80% of them female, around the crown of the plant, or along the midrib of unfolded leaves. The mites develop through the six-legged larval stage and quiescent nymphal stage with eight legs similar to the two-spotted mite. The life cycle from egg to adult requires about two weeks but varies depending on temperatures. Usually distorted leaf tissue and/or small blasted or twisted flower buds and flowers are the first damage symptoms. The foliage often will show purplish areas. The cyclamen mites feed around the crown of plants or in the flower buds. Cyclamen is usually the most seriously injured but this mite is becoming more prevalent in foliage and bedding plants.

Two-Spotted Spider mite

Several species of spider mites occur in the greenhouse. However, the two-spotted spider mite is the most destructive, attacking a wide range of floricultural crops. The eight-legged female adult mite is approximately .50 mm in length with a rounded abdomen. The adults range from pale yellow to orange to brown in color. The male can be distinguished from the female by its smaller, narrower body and pointed abdomen. Close examination of the undersurface of the leaves will show the mites to be very tiny moving dots. The two dark spots on the body are the food contents showing through the transparent body. After mating, each female mite begins laying approximately six pearly-white eggs per day. Over an average life time, 100 or more eggs are laid by a female on the undersurface of the foliage. The newly-hatched mites pass through the typical six-legged larval, protonymph and deutonymph stages. The latter is an immobile resting stage and hence a very difficult target for miticides. The life cycle from egg to adult ranges from 23 days to 15°C to ***only*** *7 days at 27°C*. Development is rapid under hot, dry conditions.

Two-spotted mites usually develop on the underside of foliage. All active stages feed through sucking mouthparts by piercing the lower epidermis. The feeding injury is characterized by the entire leaf appearing light-colored or "stippled" on the upper leaf surface. In addition to direct feeding injury, spider mites produce webbing over the foliage and flowers. If infestations are allowed to proceed without control measures, plants may be killed. Mite populations seem to "explode" at certain times of the year because the life cycle varies considerably with temperature. Other factors including relative humidity, plant nutrition and cultivar are also important.

Scale Insects



Scales are minute, wingless insects, up to 3 mm in length and have piercing-sucking mouthparts and an oval or hemispherical body shape. They secrete a characteristic waxy or scale-like covering over their bodies. The males, which are rare do have wings. Most individuals are females which lay hundreds of eggs under their immobile scale. When these hatch, small individuals called crawlers migrate to new feeding sites. Damage is caused by the removal of sap from plants causing yellowing and wilting. A number of species have been identified on greenhouse ornamentals in recent years, mainly due to the increased amount of foliar stock being imported from tropical areas. Many of the newer introductions of ferns, palms and ivy plants are quite susceptible to scale infestations. Some of the more common species are described.

Ivy scale and greedy scale These scales are similar in appearance, being pale and circular in shape with a prominent yellowish nipple in the centre. Both attack a wide variety of greenhouse plants such as ivy, palms, *Ficus* and *Fuchsia*.

Fern scale The shield of this scale resembles an oyster shell and is brown with a lighter terminal nipple. It is usually found on ferns and other foliage.

Brown soft scale Female scales are flat, brown and pliable. They have a wide host range and produce large amounts of honeydew which allows development of black, sooty mold fungus.

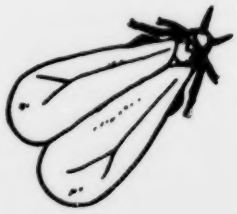
Hemispherical scale The scale covering of this species is very convex, brown and shiny. Ferns are a favorite host.

Like mealybugs, scales can be initially controlled by eliminating any introduction of infested material. Granular systemic materials and fog solutions are effective in controlling established infestations.

Thrips

Several thrip species are found in the greenhouse including flower thrips, onion thrips, chrysanthemum thrips and greenhouse thrips. Thrips are tiny, slender, agile insects about 1.5 to 3 mm in length when fully developed. Adults are usually dark brown or yellow while young thrips are usually white or yellow with red eyes. The rasping-sucking mouthparts cause white streaked areas on the leaves or translucent spots on the flower petals. Thrips deposit specks of black fecal material on leaf surfaces. The life cycle of all thrips is similar. The female adult lays her tiny white eggs inside the leaf tissues. In 5 to 7 days, the eggs hatch and white nymphs emerge which feed on the leaves and petals. They pass through several nymphal stages and a short pupal stage (in soil) before entering the adult stage. Adults can live as long as 7 weeks. A new generation may occur every 20 to 35 days depending on temperature. Thorough coverage of the host plant with insecticides is essential as thrips are small enough to hide in leaf axils or flower heads. All stages can be found throughout the year in greenhouses. The presence of thrips can be confirmed by tapping buds or flowers over a sheet of white paper.

Whiteflies



A serious pest of greenhouses, whiteflies are found on a wide variety of plants and are difficult to control. Adults are small, winged insects, white in color about 1.5 mm in length. Eggs are laid on the undersides of leaves and appear as a ring of small, black specks. A female may lay up to 400 eggs and live as long as 2 months. The nymphs which hatch in 5 to 10 days are flat and sac-like and move over the plant before settling down. Their piercing mouthparts allow them to remove sap from the plant and they produce large amounts of honeydew which promotes black, sooty mold fungus to grow. New leaf tissue is preferred by the nymphs. There they can be found feeding on the undersides of the leaves. Old pupal skins and adults may be found on the lower leaves which may have symptoms of wilt. The life cycle can be completed in 4 or 5 weeks. Granular systemic insecticides have been shown to effective in controlling this pest. It has proven to be a very persistent pest and has become resistant to pesticides which were formerly effective. Judicious use of currently recommended insecticides by alternation of materials and less frequent applications may help to prevent a rapid development of this resistance problem in your greenhouse.

OCCASIONAL GREENHOUSE PESTS

Ants

These are easily recognized by their elbowed antennae and narrow waists. They may be as small as 1½ mm or as large as 6 mm in length. In greenhouses where insect feeding has produced honeydew, ants may be a problem as they are attracted to this sweet substance. Ant trails or nests should be located in or near the greenhouse and treated.

Armyworms

Occasionally, adult moths of the armyworm may enter greenhouses and deposit eggs on plant material. The caterpillars which hatch are dark in color with longtitudinal stripes. They are voracious feeders and may do considerable harm to foliage before being noticed. Infestations may be brought under control using insecticides recommended for caterpillars.

Black Vine Weevil

Weevils or snout beetles are characterized by a hard body with a snout and elbowed antennae. This species is dull brown to black, about 9 mm in length with fine ridges along its back. Its larvae are legless grubs, white in color with a reddish-brown head and found among roots of various bedding plants. Adults actively lay eggs in June with the larvae feeding on the roots for the rest of the season. The larvae will attack a wide range of plants including roses, geraniums, ferns, gardenias and rhododendrons. Although the adult does not fly, it is able to move to new plantings easily and control measures should be directed against it during late May and June. Inspection of the roots of material introduced to the greenhouse may also prevent an infestation.

Cutworms

Adult cutworm moths are attracted to lights in a greenhouse during spring and early summer and may deposit eggs in the soil at the base of plants. The caterpillar which hatches actively feeds at night on young seedlings or transplants and burrows into the soil during the day. It is usually dull brown or grey in color with longtitudinal stripes and has the habit of curling into a tight coil when disturbed. Insecticides which are effective against caterpillars will control this pest. Weedy areas near greenhouses may also harbor cutworms and provide a constant source of reinfestation.

Grasshoppers

Grasshoppers are easily recognizable and are occasional invaders of greenhouses. They will feed on almost any vegetation and, in large numbers, can destroy plants. Grass and weeds near greenhouses may allow an infestation of these insects to occur, usually in late summer and fall. Foliar sprays such as Sevin, malathion, Cygon and diazinon are effective.

Leafhoppers

Leafhoppers are small, light-colored insects, 3 mm or less in length. They have piercing mouthparts with which they remove plant sap and cause yellowed and mottled leaves. Some species are able to transmit virus-like disease-causing organisms. Infestations in flower crops, such as chrysanthemums, can be detected by these small insects jumping and flying when the foliage is disturbed. Foliar sprays or fog solutions are an effective means of control.

Midges

These small, orange, delicate flies lay eggs on stems or leaves of the chrysanthemum. The small larvae which hatch burrow into the tissue, cause a swelling of stems and produce elongate galls on leaves. Control should be directed against the adults and early stage larvae. The adults are effectively controlled with fumigants or fogging solutions.

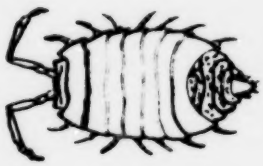
Plume Moths

Plume moth adults are only rarely found in greenhouses. They may be attracted by lights or their eggs or larvae brought in with plant material. The small, brown moth is usually found at rest with its wings outstretched in a "T" position. The caterpillars are cream colored with a brown head and may feed within webbed foliage or bore into the stems of plants such as geraniums. Fumigation is used for control.

Slugs and Snails

Slugs are dark-grey, soft-bodied creatures, varying in length from 1.3 to 10 cm which glide over the plants, leaving a slimy trail. They eat the foliage of most greenhouse plants, shredding the leaves, and may completely destroy a plant. Slugs are nocturnal, and will hide under any cover during the day.

Snails are similar in habit and appearance to slugs except that a snail carries its shell around at all times. The shells vary in color and markings, and may be 1.3 to 5 cm in diameter. Snails are particularly injurious to seedlings and eat holes in flowers and leaves on many plants, leaving them slimy and tattered. Control of these organisms is obtained with baited pesticides combining bran bait with metaldehyde.



Sowbugs/Pillbugs

Sowbugs and pillbugs have grey, flattened, oval bodies up to 13 mm in length and have 7 pairs of legs. They are scavengers, but occasionally may feed on roots and tender parts of plants causing damage to seedlings. They feed at night and hide during the day, preferring dark, moist areas with an abundance of organic matter. Soil sterilization and elimination of decaying plant material and moist areas will aid greatly in preventing any buildup of these organisms.

Springtails

These are tiny, wingless insects less than 5 mm long and generally light in color. They are usually found on the surface of moist soil in pots or within the soil. They have a springlike apparatus at the end of their abdomen which allows them to spring into the air. Springtails feed on decaying organic matter, algae or fungi. They occasionally are numerous enough to be a nuisance. Soil drenches of diazinon will control them.

Stalk Borers

One species of stalk borer, the European corn borer, is an occasional pest in greenhouses. The light tan moth is attracted to lights in late summer and may lay egg masses on foliage after entering the house. The caterpillars which hatch bore into the stems and cause damage to many plants, such as chrysanthemums and roses. Control measures should be instituted before the small larvae are able to enter the plant tissue. Screening vents may prevent the moths from entering the house.

Symphylans

They have slender, long, white bodies (1-5 mm) with 12 pairs of legs and long antennae. Found in moist soil which contains decaying organic matter, they can eat holes in roots and root hairs. Injured roots become stubby and plant takes on a stunted appearance.

Tarnished Plant Bug

These bugs, about 6 mm in length, are yellow-brown in color and have piercing mouthparts. The adults and their green nymphs can be serious pests of composites such as chrysanthemums. Eggs are inserted into plant tissue and the small nymphs complete their life cycle in about 4 weeks. They damage new growth causing distortion of foliage and dead or distorted flower buds. They are most active in the late fall and may gain access to the greenhouse from surrounding weedy areas. Foliar sprays and fumigants are effective control measures.

Vertebrate Pests

Rats and mice may be very destructive in the greenhouse. They feed on almost any food source and can cause damage by gnawing and burrowing. Norway rats and field mice are the most common vertebrate inhabitants of greenhouses. Rodenticides, as baits, are available containing such chemicals as chlorophacinone, diphacinone, warfarin, and zinc phosphide. Care should be taken to see that baits are placed in covered stations where pets cannot get them.

TREATMENT OF COMMON PROBLEMS

Snails and slugs Mesurol 2% Bait — 500 gm/100m^2
Metaldehyde — follow label directions.

Symphylans Lindane 25% WP — 150 g in water to cover 100 m^2

Leafhoppers, Grasshoppers Sevin 50% WP — 2.0 kg/1,000 L

Root Nematodes

Plants attacked by root nematodes become stunted and unthrifty. Leaves of some crops, such as roses, may be of abnormal color, suggesting a mineral deficiency. Infested plants are also prone to wilting. Loss of productivity may be the result of a reduction in the number, length and quality of flower stems (or unsightly appearance of potted plants).

Root-lesion nematode, *Pratylenchus penetrans* (Cobb) Native to Ontario soils, this can attack a wide range of greenhouse floral crops, particularly roses. All stages are threadlike and invisible to the naked eye. Invades the outer layers of young roots, causing small brown-to-black elliptical-shaped lesions which merge to discolor the roots and cause their deaths.

Northern root-knot nematode, *Meloidogyne hapla* (Chitwood) Native to Ontario soils and can attack a great number of floral crops, particularly roses, African violets and geraniums. Early larval stages are threadlike and invisible, while later stages and adults are peanut- to pearl-shaped and just visible when dissected from roots. This nematode invades roots and settles down to cause swellings, knots or galls, and excessive root proliferation. Infested roots do not necessarily become discolored unless attacked by bacteria and fungi.

Dagger nematode, *Xiphinema diversicaudatum* (Micoletzky). Not native in Ontario, but introduced into greenhouses on plant stocks. Only roses are attacked. The nematode survives in the root crotches of the understock. One of the largest nematodes attacking plants, this 6 mm long, threadlike roundworm can, with care, be seen on the roots. It feeds on young roots from the soil, causing galls not unlike root-knot galls but somewhat larger. These galls are actually curved swelling in the root-tip area, accentuated with the necrosis and shriveling of roots above the galls.

Control of Root Nematodes

Preplant Soil Fumigation

— See section on soil fumigation and steaming (page 8-10).

Postplant Soil Treatment

Dasanit* 15% G: 3.25 kg/100m^2 (330 g/m^3)

New rose bushes should be established at least 3 months before application.

Foliar Nematodes

Foliar symptoms caused by nematodes, unfortunately, are common to a number of disease and deficiency problems and do not necessarily indicate the presence of nematodes. Furthermore, because of nematodes' soil habitat and small size, specific laboratory and microscopic techniques are necessary to confirm their presence and number. There are no effective nematicides registered for use.

Strawberry bud nematode. *Aphelenchoides fragariae* (Ritzema Bos) Not native to Ontario, but introduced on plant stock, this nematode is primarly a problem on Begonia but it can attack other greenhouse ornamentals. Invisible and threadlike, it moves in moisture films on stems and leaves. It enters leaves through the stomata and feed in the inner layers of the leaf, causing small brown spots with water-soaked margins to form on the underside of leaves, which then enlarge and merge, turn dark brown and become visible on the upper surface. Finally, the entire leaf is affected.

Chrysanthemum nematode, *Aphelenchoides ritzema-bosi* (Shwartz) Not native to Ontario, this nematode is also introduced on plant stock. It is almost identical to the Strawberry bud nematode and moves and infests plants in the same manner. Dark brown spots on the underside of leaves are the early symptoms, then the veins become discolored and infested leaves turn brown or black, forming distinct wedge-shaped areas between the veins. Finally the leaves dry, shrivel, and hang down along the stems.

*There is a possibility that these chemicals are phytotoxic to a plant species or cultivar; therefore, test the chemical on a few plants before using in a major treatment.

VIRUS DISEASES

Viruses are disease-causing agents that multiply only within living plant cells. They tend to spread throughout the host plant. Depending on the virus, they are spread by sucking insects, such as aphids and leafhoppers or by tools, handling, etc. Some viruses are spread with cuttings. Vein banding, flecking, ringspots, mosaic (irregular areas of dark and light green on the leaf), or growth abnormalities may develop in the leaves, depending on the particular virus. Some viruses cause stunting.

BACTERIAL DISEASES

Control of bacterial diseases is very difficult, but fortunately they are not as common as fungus diseases. Bacterial infections may appear as wilts, stem and root rots, leaf spots, galls and fascination of plant parts. Good cultural practices and extreme care in sterilization procedures will reduce the chance of bacterial infection. Fixed copper sprays are a reasonable control for bacterial diseases *but* phytotoxicity may be a problem.

MAJOR GREENHOUSE DISEASES

FUNGUS DISEASES

Botrytis blight (Grey mold) This fungus disease may affect bulbs, stems, leaves and flowers. High humidity caused by crowding the plants, poor ventilation and leaving old leaves and flowers on the plants or soil surface all encourage an outbreak of Botrytis. Symptoms vary from host to host. If the air is very humid the organism develops a fuzzy grey growth on infected plant parts.

Leaf spots, flower spots and blights Spores of the fungi that cause these diseases are wind-borne or splashed about when watering. The leaves must be wet for infection to take place. Avoid overhead watering.

Powdery mildew May be recognized by the white powdery growth of the fungus on the leaves, stems and floral parts. The growth is sparse at first but may eventually cover the entire upper surface of the leaves. On some plants such as roses, the fungal growth may become felt-like. Affected rose leaves frequently develop a reddish discoloration. Generally, the powdery mildew fungus that affects one crop will not affect another. Spores of the fungus are spread by air currents and require high humidity for spore germination and infection of the host.

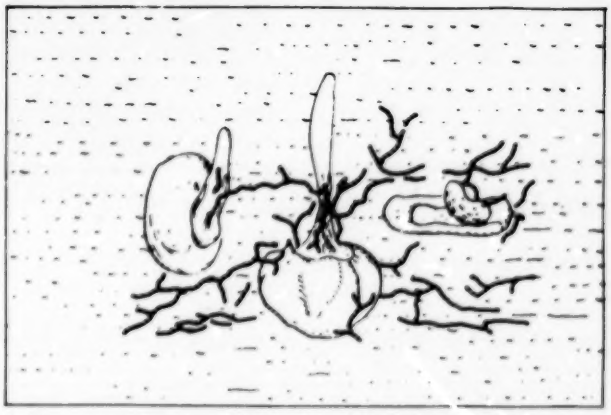
Wilt *Fusarium* and *Verticillium* fungi interfere with the water-conducting tissues in the plant. Leaves may wilt, become yellowish and eventually turn brown. Plant growth and bloom production are reduced. Plants may be killed. The fungi persist in the soil and gain entrance through the roots. Most common means of infection would be propagation of infected stock or planting susceptible plants in infested soil.

Damping-off of seedlings Wet soil, poor sanitation, poor ventilation, high humidity and thick strands of seedling are ideal conditions for damping-off fungi. There are 3 types of damping-off that can cause major problems in bedding plants.

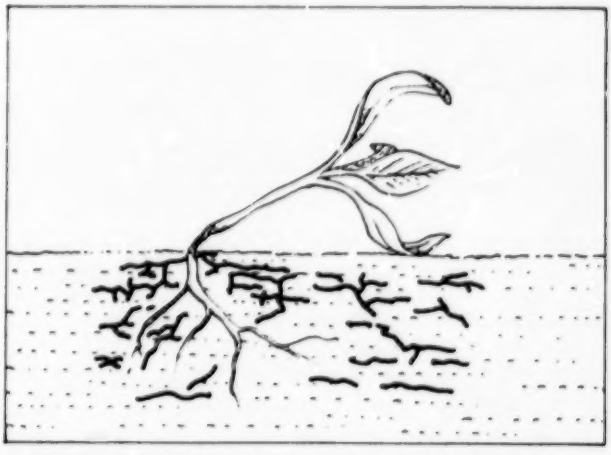
Rust Rust fungi attacking one host do not attack another. They may be identified by the masses of orange-to-dark-red or brown spores that are seen when pustules on leaves or stems break open. Rust may occur on carnation, chrysanthemum, geranium, snapdragon and others. Rust spores are spread by air currents and by splashing water. They require water on the leaf to germinate and infect the plant, and may travel long distances in infected cuttings.

Crown and root rots All the fungi described below are soil inhabitants. *Pythium* and *Phytophthora* fungi cause a rotting of the roots and crowns of many plants. The lower part of the leaf and petioles of such plants are gloxinia and African violet and stems of other plants have a water-soaked appearance. Eventually the entire plant will rot off at the ground level.

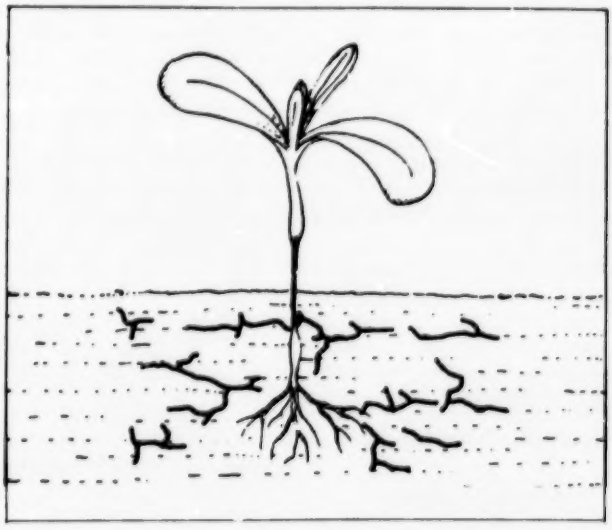
Rhizoctonia and *Fusarium* fungi cause a brown cankering of the below-ground stem and roots of infected plants.
Thielaviopsis causes a severe rotting of the roots of infected plants. The affected areas are more black in color than brown.
Sclerotinia causes a rot near the soil line, and can usually be identified by the presence of thick white mycelium on the soil surface.



1. Preemergence damping-off. The seeds are killed before germination, or soon after. The young plants never emerge from the soil. This loss is often blamed on poor seed.



2. Postemergence damping-off. Most growers are familiar with this stage. The stem is invaded near the soil surface. The seedling wilts, the stem collapses and the plant topples over. Other variations of postemergence damping-off include top rot or top damping-off, and root rot.



3. Wire-stem damping-off. Seedlings that have been hardened off may be attacked by damping-off organisms. Stems are partially girdled, discolored and wire-like in appearance; hence the name wire stem. Infected plants are stunted and eventually die.

Fungicidal Activity — Flower Crops

	Botrytis	Fusarium	Leaf Spots[1]	Powdery Mildew	Rusts	Pythium	Phytophthora	Rhizoctonia	Sclerotinia	Thielaviopsis
Acti-dione PM				X	X					
Benlate	R	R	X	R				X	X	X
Botran	X									
Captan	X		X			R				
Daconil 2787	X	X	X	X	X		X	X		
Easout	R	R	X	R						
Exotherm Termil	X									
Ferbam			X		X					
Funginex				X						
HRC Liquids systemic					X[2]					
Karathane				X						
Lesan						X	X			
Meltatox				X						
No Damp								X		
Quintozene								X	X	
Rovral	X							X	X	
Subdue						X	X			
Sulphur			X	X						
Truban						X	X			
Vitavax Captan						X		X		
Zineb, Maneb			X		R					

[1] *check label for specific leaf spot control*
[2] *Carnation rust only*
R *Indicates possible resistance*
X *indicates effective control of disease*

GROWTH REGULATORS

GROWTH REGULATORS

The use of growth regulators has become an important cultural tool in the production of greenhouse flower crops. They influence different processes in the plant such as root formation, flower induction, vegetative growth, etc. The following section will concentrate on limiting vegetative growth (height control).

1. Factors to Consider

(a) **Plant vigor** A healthy, vigorous plant is more apt to tolerate the stresses of growth regulators. For instance, the height reduction by growth retardants such as B-9, Cycocel and A-Rest will be more severe on weak plants. A-Rest applied to Easter Lilies with poor root development can cause undue loss of bottom leaves. A dehydrated plant will be more susceptible to growth regulator damage than a turgid plant. For all applications the root system of the plants should be well established.

(b) **Cultivar response** The growth habit of different cultivars may determine the concentration and the number of applications of growth regulators. A tall-growing pot mum such as the Annes would generally require a higher concentration of growth retardants than the shorter cultivars like the Mandalays.

(c) **Environment** Plants grown under low light may require less growth retardant than those under high light intensity. Therefore, the concentration may have to be adjusted accordingly for winter and summer production. A-Rest is reported to be ineffective on Easter Lilies if plants are lighted and given long days. Growth regulators should not be applied during the high heat period of the day (higher than 22° C). Preference should be given to applications during the evening when the solution does not dry up rapidly or will be affected by the sun.

(d) **Stage of plant growth** Growth regulators are generally more effective when applied to young and vigorous plants. A-Rest applied to Easter Lilies that are less than 10 cm in height may reduce bud count, delay flowering and severely stunt plant growth. When applied too late, A-Rest will produce lilies with palm-tree effect. Early application may also affect the development of some (bottom) breaks on poinsettias and crysanthemums. This is more pronounced with the higher rates or more effective growth regulators.

(c) **Dosage and coverage** It is extremely important that the correct concentration of the chemical be applied. Accurate measurement can only be made with proper weighing instruments and/or measuring containers. For Cycocel and B-9, recommendations are based on the concentration of the liquid solution being applied, whereas for A-Rest the recommendation is for drenching and expressed as total active ingredients per plant (per pot).

1 milligram of ingredient X per litre of water (1,000 g) = 1 ppm X
1 ppm = .0001% = 1 mg/L
10 ppm = .001% = 10 mg/L
100 ppm = .01% = 100 mg/L
1,000 ppm = 0.1% = 1,000 mg/L
10,000 ppm = 1.0% = 10,000 mg/L

Therefore, a 2,500 ppm B-9 concentration is a 0.25% solution containing 2,500 mg/L of active ingredient.

A-Rest contains 0.0264% active ingredient or, 264 ppm ancymidol. For 5 ppm, one needs a 1:53 dilution or 20 mL/L of water.

(f) Read the label. There are sometimes different formulations on the market and it is your responsibility to read the label and use the material accordingly. It may also give an indication about the need of a spreader sticker.

(g) Growth regulators should be stored in a similar manner as other pesticides namely in a *cool*, *dry* and *dark* site. Do not let the temperature drop below 0°C. Shelflife is at least two years. Some growth regulators may not be stable for a long time after being mixed with water. Therefore to prevent breakdown, mix just prior to use.

2. Methods of Application

(a) **Drench.** Some growth regulators are systemic within the vascular system (Cycocel and A-Rest). Drenching may provide a means of better distribution of the chemical within the plant and therefore more control. Treatment is precise but generally requires more labor. It is important that the roots be well-developed prior to application. This is critical for A-Rest drench on Easter Lilies. Make sure that plants are not under water stress, since injury can occur if plants are on the dry side. It may be wise to water the plants in late afternoon and apply the treatment the following morning. Apply adequate amounts of solution to wet the entire root mass. The following is the recommended drench volume for various pot sizes:

Pot size	Volume of drench solution
cm	mL
10	90
13	120
15	180
20	240
25	300

(b) **Spray.** Application is less laborious; however, uniform coverage of the foliage is critical. Plants should be turgid to prevent foliage damage. Keep foliage dry for 12-24 hours after spraying to prevent washing off of the chemicals from the leaves. Most chemicals contain wetting agents; however, a spreader may be required in some cases to obtain more uniform distribution of the chemical on the foliage and decrease the possibility of leaf damage. A rate of 20 L of spray/100 m^2 will generally give good coverage. To prevent excessive wastage of the chemicals, arrange the plants as close as possible without undue crowding. It is **very important** that spraying equipment is operating properly. It is desirable to keep a separate sprayer for this job and clean the sprayer after each application to safeguard against unnecessary damage from other chemical residues.

Pot size	Volume of drench solution
cm	mL
5.5	1
10	3
12.5	6
15	10
20	20

3. Number of Applications

A **single** application is naturally the most economical as a drench or spray; however, it is a "one-shot" treatment and vulnerable to mistakes.

A **split** application using one-half the suggested concentration applied twice 1-2 weeks apart does allow for more flexibility and reduces the chances of damage to plants. It also allows time to monitor plant growth, and repeated applications can be made accordingly.

4. Estimating Final Plant Height

Floriculture researchers have found the final height of Chrysanthemums and Poinsettias can be predicted. This finding can be very useful in determining the effectiveness of a growth retardant and whether additional applications are necessary. Four weeks following the start of short days, Chrysanthemum and Poinsettia reach approximately one-half of their final height at maturity. By measuring the plant height from pot rim 4 weeks following short days and doubling this height, you would have an estimation of final height. If at 4 weeks the doubling height gives an estimation of the final height that is still **too tall,** another application of growth retardant can be given on that day. This will cause a further retardation in growth, thus a more desirable plant will be produced. Growers should try this system on a trial basis to determine whether it can be incorporated into their cultural program as a growth-monitoring technique.

5. Directions for Mixing Chemicals

(a) READ THE LABEL.

(b) The final volume should include the growth regulator which is to be added. The first step is to add the chemical then make up to final volume with water. If the direction reads 60 mL B-9/L, first add 60 mL of B-9 in a suitable measuring container, then add water to the 1 L mark. **Do not add 60 mL B-9 to 1 L of water.** Remember that the final solution including B-9 should be 1 L.

(c) Don't add wetting agent (spreader) if the label informs that it is already present in the solution.

(d) Read the label to see if the material is sufficiently stable for storage after mixing. It is best to mix chemicals before each application to ensure proper activity of the chemical.

(e) Don't mix growth regulators with **any** chemicals. The application of growth regulators is too critical to warrant mixing with other chemicals. Don't take chances to save time. Take time to do the best job of mixing and applying growth regulators.

GROWTH REGULATOR RECOMMENDATIONS

PLANT	GROWTH REGULATOR	CONCENTRATION OF ACTIVE INGREDIENT	METHOD OF APPLICATION
AZALEAS	B-Nine SP (85%) (height control)	2,500-3,500 ppm (0.25-0.35%)	spray
	Cycocel (11.8%)* (height control)	2,000 ppm (0.20%)	spray
BEDDING PLANTS	B-Nine SP (85%) (height control)	2,500-5,000 ppm (0.25-0.50%)	spray
CHRYSANTHEMUMS (pot mums)	B-Nine SP (85%) (height control)	2,500-5,000 ppm (0.25-0.50%)	spray
	A-Rest (0.0264% ancymidol) (height control)	2-8 ppm (0.5-0.25 mg/15 cm pot)	drench for 2 ppm (120 mL/15 cm pot)
CHRYSANTHEMUMS (cut mums)	B-Nine SP (85%) (height control)	2,500 ppm (0.25%)	spray the top one/third of the foliage
GERANIUM (Carefree)	Cycocel (11.8%)* (height control)	2,000-3,000 ppm (0.2-0.3%)	soil drench
HYDRANGEAS	B-Nine SP (85%) (height control during forcing)	2,500-5,000 ppm (0.25-0.50%)	spray to wet foliage
LILIES	A-Rest (0.0264% ancymidol) (height control)	0.25 mg/15 cm pot	drench 180 mL of 1.3 ppm solution/15 cm pot
POINSETTIAS	B-Nine SP (85%) (height control)	5,000-7,500 ppm (0.50-0.75%)	spray
	A-Rest (0.0264% ancymidol) (height control)	2-8 ppm (0.5-0.25 mg/15 cm pot)	drench
	Cycocel (11.8%)* (height control)	1,500-3,000 ppm (0.15-0.30%)	spray or drench

*) make adjustment in mixing rates when using Cycocel Extra.

FOR GREENHOUSE FLORICULTURE CROPS

MIXING RATES METRIC	TIME OF APPLICATION	COMMENTS
3.0-4.2 g/L of water	After last pinch when shoots are 2.5 cm long (6 weeks after pinching). Apply early morning.	Increases short day response and early bud formation. Don't let solution drip on medium.
20 mL/L of water	Apply during short day treatment twice, with 1-week interval.	Can produce medium-hard plants, slight chlorosis and/or uneven flowering. Also used to promote early flowering on some varieties.
3.0-6.0 g/L of water	2-4 weeks after transplanting when plants are 3-5 cm diameter. May be repeated 4 weeks later.	Good for most bedding plants but not effective on snapdragons, celosia, coleus, pansies, pelargonium (geranium), carnation, cleome, convolvulus and gomphrena.
3.0-6.0-g/L of water	Apply when shoots are 2-4 cm long. May be repeated 3 weeks later.	Use the low concentration to the pinched crops and the high concentration to the single stem pot mum. Spray to wet foliage.
for 2 ppm mix: 8 mL/L of water	Apply just as root system spreads over outside soil ball.	For 2 ppm dilute 1:128. Entire soil must receive uniform application. A-Rest contains a wetting agent.
3.0 g/L of water	Two days after dis-budding or 4 weeks after shade initiation.	Do not mix B-9 with any other pesticides.
For 2,500 ppm mix: 21 mL/L of water	3 weeks after transplanting.	May cause some marginal leafburn. Induces earlier flowering.
3.0-6.0- g/L of water	Apply first spray between 2 & 3 weeks (4-5 leaf stage); 2nd spray one week later.	Can apply after buds are visible if necessary.
for 1.3 ppm mix: 5 mL/L of water	Apply when lilies are 7-15 cm tall. Do not apply Jan. 23-Feb. 7, as bud count may be reduced.	Can also be used as a spray. Spray may affect flower bud count. Not very effective if bark medium is used.
6.0-9.0 g/L of water	Spray when shoots are approx. 5 cm tall.	Do not add any wetting agent. Late application may delay blooming.
for 2 ppm mix: 8 mL/L of water	Treat plant at pinch to 4 weeks after pinch, or 8 to 12 weeks before finishing.	Do not add a wetting agent. Use 125-150 mL of solution to a 15 cm tall.
13-25 mL/L of water	Apply when shoots are 2-4 cm tall.	Application later than Oct. 10 may delay flower development. Spraying twice with one-half the recommended concentration is more effective than once with the high concentration.

PESTICIDE INJURY TO FLOWER CROPS

Although greenhouse insecticides have been selected and formulated to avoid plant injury, damage can still occur under some conditions. No insecticides are safe on all plants under all conditions, although wettable powders are generally less injurious than liquid formulations. In many cases, a material may be safe when applied to dry foliage but can cause injury when used on wet foliage. Here is a list of possible hazards.

1. **Acti-Dione P.M.** may injure new growth on roses, especially during hot weather.
2. **Cygon** will injure many Chrysanthemum varieties.
3. **Daconil 2787** may damage open blooms.
4. **DDVP** (Vapona, dichlorvos) is injurious on some Chrysanthemum varieties especially Shasta and Pink Champagne. Also damages some varieties of snagdragons, tradescantia, some crassulas, ferns and some rose varieties.
5. **Diazinon** is not for use on Gardenias, Poinsettias, Hibiscuses, Stephanotis, Pileas, Hydrangeas, Cyclamen foliage.
6. **Dibrom** injures some ornamentals including some Chrysanthemum varieties and can cause flower damage to cucumbers.
7. **Dylox** damages some carnation, Chrysanthemums and Zinnia varieties.
8. **Lindane** injures Hydrangeas, Poinsettias.
9. **Lorsban** is known to be phytotoxic to azaleas, geraniums, coleus, roses, some chrysanthemum varieties (eg. Marbels), camellias, poinsettias, oxalis and varigated ivy. Caution should be taken when applying this product to exotic or tropical plants.
10. **Malathion** should not be used on fern, Petunias and Crassulas, orchids, sweetpeas, cucurbits, Saintpaulia, Gloxinia, Rieger Begonias, some carnation and rose varieties.
11. **Manzate 200** may cause stunting when used as repeated soil drenches on cyclamen, exacum and poinsettia, particularly when soil is dry.
12. **Metaldehyde** has reportedly damaged Cattleya and Phalaenopsis orchids when applied as sprays and dusts.
13. **Meta-Systox R** damages lilies, Rieger Begonias, geraniums and Chrysanthemum varieties Huricane, Iceburg, Whitetop and Pennant.
14. **Morestan** has damaged rose varieties.
15. **Nicotine** may injure lilies and some Chrysanthemum varieties. Do not smoke on open blooms of snapdragons, geraniums or African Violets.
16. **Orthene** is injurious to African Violets, poinsettias, gloxinia and many varieties of geraniums.
17. **Parathion** may prove harmful to Gardenias, Hydrangeas, Crassulas, ferns, Kalanchoes, asters, Cycamens, tender foliage plants, Rieger Begonias and succulents. May cause leaf drop on roses if used within 7 days of sulfur, particularly in the fall or winter.

CAUTION — Parathion may have a bleaching effect on the open blooms of all flower crops.

18. **Plictran** can damage Chyrysanthemum blooms and poinsettia bracts.
19. **Pentac Aquaflow** causes some foliage damage on Chrysanthemums. Do not apply to open blooms.
20. **Pirimor** should not be applied to Icecap, Goldcap and related varieties of Chrysanthemums.
21. **Safers Insecticidal Soap** should not be used on Poinsettias, Maidenhair Fern, Sweetpea or Nasturtium.
22. **Sevin** (carbaryl) should not be used on Boston Ivy or Virginia Creeper.
23. **Tedion** (tetradifon) may cause injury to some roses, especially White Butterfly and Cinderella.
24. **Thiodan** (endosulfan) may injure some geranium varieties. Emulsifiable concentrate has injured Bonnaffon Deluxe and some othe Chrysanthemum varieties. Ther have been reports of injury to Cineraria, Gardenia, Gloxinia, Poinsettia, Rose, African Violet and Pothos. If plants are well watered and not stressed there is less likelihood of damage.

PEST AND DISEASE CONTROL FOR FLOWER CROPS*

PROBLEM	RECOMMENDATION BY TRADE NAME	FOR 1000 L	OTHER
	AFRICAN VIOLET (Saintpaulia)		
Aphid	Thiodan 4 EC or Thiodan 50% WP	1.25 L 1.0 kg	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m³ 35 mL/100 m³
	Dibrom Insecticide		20 mL/100 m³
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m³ 35 mL/100 m³
	Insecticidal Soap	20 L	
Cyclamen Mite	Kelthane 18.5% EC or Kelthane 35% WP Thiodan 50% WP or Thiodan 4 EC	1.25 L 750 g 1.0 kg 1.25 L	35 mL/100 m³
Fungus Gnat	Malathion 50 EC	2.0 L	
	Lindane Smoke Fumigator		1/300 m³
Mealybug	DDVP Smoke Fumigator		1/300 m³
	Lorsban 25% WP	3.84 kg	
	Diazinon 50% EC or Diazinon 50% WP	0.63-1.25 L 1.0-1.5 kg	
	Lindane 25 WP	1.0 kg	
	Dibrom Insecticide		20 mL/100 m³
	Insecticidal Soap	20 L	
Thrips	Diazinon 50% EC or Diazinon 50% WP	0.63-1.25 L 1.0-1.5 kg	
	Lindane Smoke Fumigator or Lindane 25 WP	1.0 kg	1/300 m³
Twospotted Spider Mite	Tedion V-18 Smoke Fumigator		1/300 m³
	Insecticidal Soap Kelthane 18.5% EC or Kelthane 35% WP or Kelthane Fog Solution	20 L 1.25 L 750 g	35 mL/100 m³
	Vendex 50% WP Plictran 50% WP	0.5-1.0 kg 250-375 g	

The recommendations in this section (page 00 to 00) are for flower crops **only.*

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Botrytis	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Captan 50% WP	2.0 kg	
	Captan 80% WP	1.5 kg	
	Rovral 50% WP	1.0 kg	
	Exotherm Termil Smoke Fumigator		1/300 m^3
Crown Rot	Subdue 2G		125-250 g/m^3 - preplant incorporated 125-1000 g/100 m^2 - surface application - see directions
	Lesan 35% WP	450-900 g Apply to 100 m^2	
	Truban 30% WP	175-625 g	
Powdery Mildew	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
		AZALEA	
Aphid	Thiodan 4 EC or Thiodan 50 WP	1.25 L 1.0 kg	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Dibrom Insecticide		20 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Trumpet 80 W	.75-1.0 kg	
	Insecticidal Soap	20 L	
Cyclamen Mite	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
Leafroller	Dipel	0.63-1.25 kg	
Thrips	Diazinon 50 EC or Diazinon 50 WP	0.63-1.25 L 1.0-1.5 kg	
	Lindane Smoke Fumigator or Lindane 25% WP	1.0 kg	1/300 m^3
	Malathion 50 EC	2.0 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Trumpet 80 W	.75-1.0 kg	1.25 kg/ha drench

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Twospotted Spider Mite	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	Pentac Aqua Flow	650 mL	
	or Pentac 50% WP	625 g	
	Vendex 50% WP Plictran 50% WP	1.0 kg 250-375 kg	
	Insecticidal Soap	20 L	
Whitefly	Thiodan 4 EC or Thiodan 50 WP	1.25 L 1.0 kg	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Dibrom Insecticide		20 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Pounce 384 EC	275 mL	
	Insecticidal Soap	10 L	
Petal Blight	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	BEDDING PLANTS		
Aphid	Pirimor 50% WP	500 g	
	Nicotine Smoke Fumigator		1/300 m^3
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Dibrom Insecticide		20 mL/100 m^3
	Insecticidal Soap	20 L	
	Trumpet 80 W	.75-1.0 kg	due to diversity of types, test a few plants first
Fungus Gnat	Lindane Smoke Fumigator or Lindane Fog Solution		1/300 m^3 35 mL/100 m^3
	Diazinon 50 WP	1.5 kg	soil drench

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Twospotted Spider Mite	Pentac Aqua Flow or Pentac 50 WP or Pentac Fog Solution	650 mL 625 g	 35 mL/100 m³
	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m³ 35 mL/100 m³
	Tedion V-18 Smoke Fumigator		1/300 m³
	Vendex 50% WP Plictran 50% WP	0.5-1.0 kg 250-375 g	
	Insecticidal Soap	20 L	
Whitefly	Ambush 50 EC	200 mL	
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m³ 35 mL/100 m³
	Pounce 384 EC	275 mL	
	Insecticidal Soap	10 L	
	Parathion Smoke Fumigator		1/300 m³
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m³ 35 mL/100 m³
	Thiodan 50 WP or Thiodan 4 EC	1.0 kg 1.25 L	
	Trumpet 80 W	.75-1.0 kg	
	Dibrom Insecticide		20 mL/100 m³
Botrytis	Exotherm Termil Smoke Fumigator		1/300 m³
	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Captan 50% WP or Captan 80% WP	2.0 kg 1.5 kg	
	Rovral 50% WP	1 kg	
Damping-Off	Truban 30% WP	250-375 g	
	Lesan 35% WP	600-750 g Apply to 100 m²	
	Quintozene 20% WP or Quintozene 75% WP		4-6 kg/100 m² 1.0-1.25 kg/100 m²
	Vitavax-Captan 30% WP	250 g	
	No-Damp	10 L	
	Rovral 50% WP		2 g/5 L/m²
Powdery Mildew	Benlate 50% WP + Manzate 200	500 g 2.5 kg	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
	BEGONIA (Rieger)		
Aphid	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m³ 35 mL/100 m³
	Trumpet 80 W	.75-1.0 kg	
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m³ 35 mL/100 m³
	Insecticidal Soap	20 L	
Mealybug	Malathion 50% EC	2.0 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m³ 35 mL/100 m³
	Diazinon 50% WP or Diazinon 50 EC	1.0-1.5 kg 0.63-1.25 L	
	Lorsban 25% WP	3.84 kg	
	Trumpet 80 W	.75-1.0 kg	
	Dibrom Insecticide		20 mL/100 m³
	Insecticidal Soap	20 L	
Thrips	Diazinon 50% WP or Diazinon 50% EC	1.0-1.5 kg 0.63-1.25 L	
	Lindane Smoke Fumigator or Lindane Fog Solution or Lindane 25% WP	 1.0 kg	1/300 m³ 35 mL/100 m³
	Malathion 50% EC	20 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m³ 35 mL/100 m³
	Trumpet 80 W	.75-1.0 kg	1.25 kg/ha drench
Twospotted Spider Mite	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	Tedion V-18 Smoke Fumigator		1/300 m³
	Vendex 50% WP Plictran 50% WP	0.5-1.0 kg 250-375 g	
	Insecticidal Soap	20-25 L	
Whitefly	Ambush 50 EC	200 mL	
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m³ 35 mL/100 m³
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m³ 35 mL/100 m³
	Pounce 384 EC	275 mL	
	Trumpet 80 W	.75-1.0 kg	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
	Insecticidal Soap	20 L	
Botrytis	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Botran 75% WP	925 g	
	Captan 50% WP or Captan 80% WP	2.0 kg 1.5 kg	
	Rovral 50% WP	1.0 kg	
Root Rot (Cuttings)	Lesan 35% WP	0.50-1.0 kg Apply to 100 m^2	
	Truban 30% WP	175-625 g	
	Captan 50% WP or Captan 80% WP	2.0 kg 1.5 kg	
	Vitavax-Captan 30% WP	250 g	
Powdery Mildew	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
		BULB CROPS	
Tulip Bulb Aphid	Lindane 25% WP or Lindane Smoke Fumigator or Lindane Fog Solution	1.0 kg	 1/300 m^3 35 mL/100 m^3
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	Dibrom Insecticide		20 mL/100 m^3
Botrytis	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Captan 50% WP or Captan 80% WP	2.0 kg 1.5 kg	
	Daconil 2787	2.5 L	
Blight	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Daconil 2787	2.5 L	
Crown Rot	Truban 30% WP	175-625 g	
		CALCEOLARIA	
Aphid	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
	Lindane 25% WP or Lindane Smoke Fumigator or Lindane Fog Solution	1.0 kg	 1/300 m³ 35 mL/100 m³
	Insecticidal Soap	20 L	
Fungus Gnat	Malathion 50 EC	2.0 L	
	Lindane 25% WP or Lindane Smoke Fumigator or Lindane Fog Solution	1.0 kg	 1/300 m³ 35 mL/100 m³
Thrips	Lindane 25% WP or Lindane Smoke Fumigator or Lindane Fog Solution	1.0 kg	 1/300 m³ 35 mL/100 m³
Twospotted Spider Mite	Vendex 50% WP Plictran 50% WP	0.5-1.0 kg 250-375 g	
	Insecticidal Soap	20 L	
Whitefly	Insecticidal Soap	10 L	
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m³ 35 mL/100 m³
	Dibrom Insecticide Pounce EC	 275 mL	20 mL/100 m³
Botrytis	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Captan 50% WP or Captan 80% WP	2.0 kg 1.5 kg	
Powdery Mildew	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	CARNATION		
Aphid	Diazinon 50% EC or Diazinon 50% WP	0.63-1.25 L 1.0-1.5 kg	
	Nicotine Smoke Fumigator		1/300 m³
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m³ (under 20°C) 35 mL/100 m³
	Dibrom Insecticide		20 mL/100 m³
	Trumpet 80 W	.75-1.0 kg	
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m³ 35 mL/100 m³
	Insecticidal Soap	20 L	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Thrips	Trumpet 80 W	.75-1.0 kg	1.25 kg/ha drench
	Lindane 25% WP	1.0 kg	
	or Lindane Smoke Fumigator		1/300 m^3
	or Lindane Fog Solution		35 mL/100 m^3
	Diazinon 50% WP	1.0-1.25 kg	
	or Diazinon 50% EC	0.63-1.25 L	
	or Diazinon Fog Solution		35 mL/100 m^3
Twospotted Spider Mite	Pentac Aqua Flow	650 mL	
	or Pentac 50% WP	625 g	
	Kelthane 18.5% EC	1.25 L	
	or Kelthane 35% WP	750 g	
	Vendex 50% WP	0.5-1.0 kg	
	Plictran 50% WP	250-375 g	
	Insecticidal Soap	20 L	
	DDVP Smoke Fumigator		1/300 m^3
	or DDVP Fog Solution		35 mL/100 m^3
Alternaria Leaf Spot	Captan 7.5% Dust		
	or Captan 50% WP	2.0 kg	
	or Captan 80% WP	1.5 kg	
	Daconil 2787	2.5 L	
Botrytis	Exotherm Termil Smoke Fumigator		1/300 m^3
	Daconil 2787	2.5 L	
Fusarium Stem Rot	Benlate 50% WP	500 g	
	+ Manzate 200	2.5 kg	
Greasy Blotch	Captan 7.5% Dust		
	or Captan 50% WP	2.0 kg	
Leaf Spot	Ferbam 76% WP	1.0-1.5 kg	
	Daconil 2787	2.5 L	
Rhizoctonia Stem Rot	Subdue 2G		125-250 g/m^3 - preplant incorporated 125 - 1000 g/100m^2 - surface application - see directions
	Quintozene 20% Dust		4 kg/100 m^2
	or Quintozene 75% WP		1.25 kg/100 m^2
	Vitavax-Captan 30% WP	350 g	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
	CHRYSANTHEMUM		
Aphid	Pirimor 50% WP	500 g	
	Diazinon 50% WP	1.0-1.5 kg	
	or Diazinon 50 EC	0.63-1.25 L	
	or Diazinon Fog Solution		35 mL/100 m³
	Nicotine Smoke Fumigator		1/300 m³
	DDVP Smoke Fumigator		1/300 m³
	or DDVP Fog Solution		35 mL/100 m³
	Trumpet 80 W	.75-1.0 kg	
	Meta-Systox R 240 SC	2 L	
	Sulfotep Smoke Fumigator		1/300 m³
	or Sulfotep Fog Solution		35 mL/100 m³
	†Temik 10G (see note page 10)		550 g/100 m²
	Insecticidal Soap	20 L	
Caterpillar	Thuricide HPC	5 L	
	Dipel	1.0-1.25 kg	
Cyclamen Mite	Kelthane 18.5% EC	1.25 L	
	or Kelthane 35% WP	750 g	
	Thiodan 50% WP	1.0 kg	
	or Thiodan 4 EC	1.25 L	
Leafhopper	Lindane 25% WP	1.0 kg	
	or Lindane Smoke Fumigator		1/300 m³
	or Lindane Fog Solution		35 mL/100 m³
	Malathion 50% EC	1.88 L	
Leaf Miner	Afugan 30EC*	1.5L	
	Diazinon 50% WP	1.0-1.5 kg	
	or Diazinon 50 EC	0.63-1.25 L	
	†Temik 10G		550 g/100 m² (see note page 10)
	Ambush 50 EC	200 mL	
Leaftier	Diazinon 50% WP	1.0-1.5 kg	
	or Diazinon 50% EC	0.63-1.25 L	
Midge	Parathion Smoke Fumigator		1/300 m³
	Lindane Smoke Fumigator		1/300 m³
	or Lindane Fog Solution		35 mL/100 m³
	Sulfotep Smoke Fumigator		1/300 m³
	or Sulfotep Fog Solution		35 mL/100 m³

**Temporary registration restricted to chrysanthemum growers.*
†Minimum period before reentry is 48 hours.

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Leaf Spot	Daconil 2787	2.5 L	
	Captan 7.5% Dust or Captan 50% WP	2.0 kg	
Powdery Mildew	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
Tarnished Plant Bug	Lindane 25% WP	1.0 kg	
	or Lindane Smoke Fumigator		1/300 m^3
	or Lindane Fog Solution		35 mL/100 m^3
	Malathion 50% EC	1.88 L	
Thrips	Trumpet 80 W	.75-1.0 kg	1.25 kg/ha drench
	or Diazinon 50% WP	1.0-1.5 kg	
	or Diazinon 50 EC	0.63-1.25 L	
	Lindane 25% WP	1.0 kg	
	or Lindane Smoke Fumigator		1/300 m^3
	or Lindane Fog Solution		35 mL/100 m^3
Twospotted Spider Mite	Pentac Aqua Flow	650 mL	
	or Pentac 50% WP	625 g	
	Tedion V-18 Smoke Fumigator		1/300 m^3
	Kelthane 18.5% EC	1.25 L	
	or Kelthane 35% WP	750 g	
	Meta-Systox R 240 SC	2.0 L	
	[2]Temik 10G		550 g/100 m^2 (see note page 10)
	Vendex 50% WP	0.5-1.0 kg	
	Plictran 50% WP	250-375 g	
	Insecticidal Soap	20 L	
Whitefly	Ambush 50 EC	200 mL	
	Insecticidal Soap	10 L	
	Sulfotep Smoke Fumigator		1/300 m^3
	or Sulfotep Fog Solution		35 mL/100 m^3
	or Dibrom Insecticide		20 mL/100 m^3
	DDVP Smoke Fumigator		1/300 m^3
	or DDVP Fog Solution		35 mL/100 m^3
	[2]Temik 10G		550 g/100 m^2 (see note page 10)
	Pounce 384 EC	275 mL	
Ascochyta Ray Blight	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Zineb 3.9% Dust		
	Daconil 2787	2.5 L	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Botryis	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Exotherm Termil Smoke Fumigator		1/300 m^3
	Daconil 2787	2.5	
	Botran 75% WP	925 g	
	Rovral 50% WP	1.0 kg	
Root Rot	Lesan 35% WP	450-900 g Apply to 100 m^2	
	Truban 30% WP	175-625 g	
	Subdue 2G		125-250 g/m^3 - preplant incorporated 125-1000 g/100 m^3 - surface application - see directions
	Vitavax-Captan 30% WP	350 g	
	CINERARIA		
Aphid	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Insecticidal Soap	20 L	
Twospotted Spider Mite	Kelthane 18.5 % EC or Kelthane 35% WP	1.25 L 750 g	
	Insecticidal Soap	20-25 L	
	Tedion V-18 Smoke Fumigator		1/300 m^3
	Vendex 50% WP Plictran 50% WP	0.5-1.0 kg 250-375 g	
Whitefly	Thiodan 50 WP or Thiodan 4 EC	1.0 kg 1.25 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Dibrom Insecticide		20 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Pounce 384 EC	275 mL	
	Insecticidal Soap	10 L	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Botrytis	Benlate 50% WP + Manzate 200	500 g 2.5 g	
	Botran 75% WP	925 g	
	Captan 7.5% Dust or Captan 50% WP or Captan 80% WP	 2.0 kg 1.5 kg	
	Rovral 50% WP	1.0 kg	
Powdery Mildew	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
Stem Rot	Lesan 35% WP	450-900 g Apply to 100 m^2	
	Vitavax-Captan 30% WP	250 g	
		CYCLAMEN	
Aphid	Nicotine Smoke Fumigator		1/300 m^3
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^2 35 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Insecticidal Soap	20 L	
Cyclamen Mite	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
Fungus Gnat	Diazinon 50% WP or Diazinon 50% EC	0.75-1.10 kg 0.63-1.25 L	
	Malathion 50% EC	2.0 L	
	Lindane 25% WP or Lindane Smoke Fumigator or Lindane Fog Solution	1.0 kg	 1/300 m^3 35 mL/100 m^3
Twospotted Spider Mite	Vendex 50% WP Plictran 50% WP	0.5-1.0 kg 250-375 g	
	Insecticidal Soap	20 L	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Botrytis	Benlate 50% WP + Manzate 200	500 g 2.5 g	
	Botran 75% WP	925 g	
	Captan 7.5% Dust or Captan 50% WP or Captan 80% WP	 2.0 kg 1.5 kg	
	Rovral 50% WP	1.0 kg	
	Exotherm Termil Smoke Fumigator		1/300 m^3
Fusarium Root Rot	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	EXACUM		
Twospotted Spider Mite	Pentac Aqua Flow	650 mL	
Botrytis	Benlate 50% WP Manzate 200	500 g 2.5 kg	
	Rovral 50% WP	1.0 kg	
Fusarium Root and Stem Rot	Benlate 50% WP + Manzate 200	500 g 2.5 kg	

FOLIAGE PLANTS

NOTE:

Due to the diversity of foliage plants and the lack of factual information on varietal damage, these recommendations are for **TRIAL USE ONLY.**

Aphid	Pirimor 50% WP	500 g	
	Malathion 50 EC	2.0 L	
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Trumpet 80 W	.75-1.0 kg	
	Dibrom Insecticide		20 mL/100 m^3

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Brown Soft Scale	Malathion 50% EC	2.0 L	
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Trumpet 80 W	.75-1.0 kg	
	Insecticidal Soap	20 L	
Cyclamen Mite	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
Mealybug	Lorsban 25% WP	3.84 kg	
	Malathion 50% EC	2.0 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Diazinon 50% WP or Diazinon 50% EC	0.75-1.0 kg 0.63-1.25 L	
	Trumpet 80W	.75-1.0 kg	
	Lindane 25% WP or Lindane Smoke Fumigator or Lindane Fog Solution	1.0 kg	 1/300 m^3 35 mL/100 m^3
	Dibrom Insecticide		20 mL/100 m^3
Twospotted Spider Mite	Pentac Aqua Flow or Pentac 50% WP or Pentac Fog Solution	650 g 625 g	 35 mL/100 m^3
	Kelthane 35% WP or Kelthane 18.5% EC or Kelthane Fog Solution	750 mL 1.25 L	 35 mL/100 m^3
	Vendex 50% WP	0.5-1.0 kg	
	Plictran 50% WP	250-375 g	
Whitefly	Ambush 50 EC	200 mL	
	Trumpet 80W	.75-1.0 kg	
	Pounce 384 EC	275 mL	
	Insecticidal Soap	20 L	
Root Rot (Cuttings)	Captan 7.5% Dust or Captan 50% WP or Captain 80% WP	2.0 kg	
	Lesan 35 WP	450-900 g Apply to 100 m^2	
	Truban 30% WP	175-625 g	
	Benlate 50% WP + Manzate 200	500 g 2.5 kg	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
	Daconil 2787	2.5 L	
	Vitavax-Captan 30% WP	250 g	
Botrytis	Rovral 50% WP	1.0 kg	
Leaf Spots and Blights	Daconil 2787	2.5 L	
		GERANIUM	
Aphid	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Trumpet 80W	.75-1.0 kg	
	Pirimor 50% WP	500 g	
	Nicotine Smoke Fumigator		1/300 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Insecticidal Soap	20 L	
Fungus Gnat	Diazinon 50% WP or Diazinon 50% EC	1.0-1.5 kg 0.63-1.25 L	soil drench
	Trumpet 80W	.75-1.0 kg	
	Lindane 25% WP or Lindane Smoke Fumigator or Lindane Fog Solution	1.0 kg	1.25 kg/ha drench 1/300 m^3 35 mL/100 m^3
Mealybug	Diazinon 50% WP or Diazinon 50% EC	1.0-1.5 kg 0.63-1.25 L	
	Trumpet 80W	.75-1.0 kg	
	Malathion 50% EC	2.0 L	
	Dibrom Insecticide		20 mL/100 m^3
Plume Moth	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
Twospotted Spider Mite	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	Insecticidal Soap	20-25 L	
	Vendex 50% WP	0.5-1.0 kg	
	Plictran 50% WP	250-375 g	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Whitefly	Ambush 50 EC	200 mL	
	Thiodan 50% WP or Thiodan 4 EC Trumpet 80W	1.0 kg 1.25 L .75-1.0 kg	
	Insecticidal Soap	20 L	
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Dibrom Insecticide		10 mL/100 m^3
	Pounce 384 EC	275 mL	
Botrytis	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Botran 75% WP	925 g	
	Exotherm Termil Smoke Fumigator		1/300 m^3
	Daconil 2787	2.5 L	Foliage only
	Captan 7.5% Dust or Captan 50% WP or Captan 80% WP	 2.0 kg 1.5 kg	
	Rovral 50% WP	1.0 kg	
Damping Off Stem and Root Rots	Subdue 2G		125-250 g/m^3 - preplant - incorporated 125-1000 g/100 m^2 - surface application - see directions
Rust	Daconil 2787 Zineb 3.9% dust	2.5 L	Foliage only
		GERBERA	
Twospotted Spider Mite	Pentac Aqua Flow Kelthane 35% WP or Kelthane 18.5% EC	650 mL 750 g 1.25 L	
Thrip	Lindane 25% WP or Lindane Smoke Fumigator or Lindane Fog Solution	1.0 kg	 1/300 m^3 35 mL/100 m^3
	Diazinon 50% WP or Diazinon 50% EC or Diazinon Fog Solution	1.0-1.25 kg 0.63-1.25 L	 35 mL/100 m^3
Whitefly	Insecticidal Soap	10 L	
Phytophthora Crown Rot	Lesan 35% WP	450-900 g Apply to 100 m^2	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
		GLOXINIA	
Aphid	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Dibrom Insecticide		10 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Insecticidal Soap	20 L	
Thirps	Diazinon 50% WP or Diazinon 50% EC	1.0-1.5 kg 0.63-1.25 L	
	Lindane 25% WP or Lindane Smoke Fumigator or Lindane Fog Solution	1.0 kg	 1/300 m^3 35 mL/100 m^3
Twospotted Spider Mite	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	Insecticidal Soap	20 L	
	Vendex 50% WP	0.5-1.0 kg	
	Plictran 50% WP	250-375 g	
Root, Stem, Crown and Tuber Rot	Lesan 35% WP	450-900 g Apply to 100 m^2	
	Truban 30% WP	175-625 g	
	Subdue 2G		125-250 g/m^3 - preplant - incorporated 125-1000 g/100 m^2 - surface application - see directions
	Vitavax-Captan 30% WP	250 g	
Botrytis	Rovral 50% WP	1.0 kg	
	Exotherm Termil Smoke Fumigator		1/300 m^3
	Daconil 2787	2.5 L	
		GYPSOPHILA	
Twospotted Spider Mite	Pentac Aqua Flow Kelthane 35% WP or Kelthane 18.5% EC	650 mL 750 g 1.25 L	
Thrip	Diazinon 50% WP or Diazinon 50% EC	1.0-1.5 kg 0.63-1.25 L	
	Lindane 25% WP or Lindane Smoke Fumigator or Lindane Fog Solution	1.0 kg	 1/300 m^3 35 mL/100 m^3

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
		HYDRANGEA	
Aphid	Trumpet 80W	.75-1.0 kg	
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Dibrom Insecticide		20 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Insecticidal Soap	20 L	
Twospotted Spider Mite	Kelthane 18.5 EC or Kelthane 35% WP	1.25 L 750 g	
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	Vendex 50% WP	0.5-1.0 kg	
	Plictran 50% WP	250-375 g	
	Insecticidal Soap	20 L	
Botrytis	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Captan 7.5% Dust or Captan 50% WP or Captan 80% WP	 2.0 kg 1.5 kg	
	Rovral 50% WP	1.0 kg	
	Exotherm Termil Smoke Fumigator		1/300 m^3
	Daconil 2787	2.5 L	on Foliage only
Leaf Spots	Daconil 2787	2.5 L	
Rust	Daconil 2787	2.5 L	
Powdery Mildew	Benlate 50% WP + Manzate 200	500 kg 2.5 kg	
Root Rot	Lesan 35% WP	450-900 g Apply to 100 m^2	
	Vitavax-Captan 30% WP	250 g	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
		LILY (Easter)	
Aphid	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	Sulfotep Smoke Fumigator or Lindane Fog Solution		1/300 m^3 35 mL/100 m^3
	Insecticidal Soap	20 L	
Fungus Gnat	Diazinon 50% WP or Diazinon 50% EC	1.0-1.5 kg 0.63-1.25 L	soil drench
	Lindane Smoke Fumigator or Lindane Fog Solution		1/300m^3 35 mL/100 m^3
Twospotted Spider Mite	Vendex 50% WP Plictran 50% WP	0.5-1.0 kg 250-375 kg	
	Insecticidal Soap	20 L	
Botrytis	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Exotherm Termil Smoke Fumigator		1/300 m^3
	Rovral 50% WP	1.0 kg	
	Daconil 2787	2.5 L	
Root Rot	Lesan 35 WP	450-900 g Apply to 100 m^2	
	Truban 30% WP	175-625 g	
	Vitavax-Captan 30% WP	250 g	
		POINSETTIA	
Brown Soft Scale	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Malathion 50% WP	2.0 kg	
	Insecticide Soap	20 L	
Fungus Gnat	Diazinon 50% WP or Diazinon 50% EC	1.0-1.5 kg 0.63-1.25 L	
	Lindane Smoke Fumigator or Lindane Fog Solution		1/300 m^3 35 mL/1000 m^3

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Mealybug	Malathion 50% EC	2.0 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Lindane 25% WP	1.0 kg	
	Parathion Smoke Fumigator		1/300 m^3
	Dibrom Insecticide		20 mL/100 m^3
Twospotted Spider Mite	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	Pentac Aqua Flow or Pentac 50% WP or Pentac Fog Solution [2]Temik 10 G	650 mL 650 g	 35 mL/100 m^3 550 g/100 m^2 (see note page 10)
	Vendex	0.5-1.0 kg	
	Plictran 50% WP	250-375 g	
Whitefly	Ambush 50 EC	200 mL	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Thiodan 50% WP	1.0 kg	
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	[2]Temik 10G		550 g/100 m^2 (see note page 00)
	Pounce 384 EC	275 mL	
Botrytis	Daconil 2787	2.5 L	
	Exotherm Termil Smoke Fumigator		1/300 m^3
	Rovral 50% WP	1.0 kg	
	Botran 75% WP	925 g	
Damping Off Stem rots	Subdue 2G		125-250 g/m^3 - preplant incorporated 125-1000 g/100m^2 - surface application - see directions
Rhizocotonia Stem Rot	Quintozene 20% Dust or Quintozene 75% WP		4 kg/100 m^2 1.0-1.25 kg/100 m^2
	Benlate 50% WP + Manzate 200	500 g 2.5 kg	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Root Rot	Lesan 35% WP	450-900 g Apply to 100 m^2	
	Quintozene 20% Dust or Quintozene 75% WP		6 kg/100 m^2 0.98-2.73 kg/100 m^2
	Subdue 2 g		125-250 g/m^3 — preplant incorporated 125-1000 g/100 m^2 — surface application — see directions
	Truban 30% WP	175-625 g	
	Benlate 50% WP + Manzate 200 Vitavax-Captan 30% WP	500 g 2.5 kg 250 g	
	ROSE		
Aphid	Pirimor 50% WP	500 g	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Trumpet 80W	.75-1.0 kg	
	Nicotine Smoke Fumigator		1/300 m^3
	Orthene 75% SP	850 g	
	Insecticidal Soap	20 L	
Brown Soft Scale	Malathion 50% EC Sulfotep Smoke Fumigator or Sulfotep Fog Solution	2.0	 1/300 m^3 35 mL/100 m3
	Trumpet 80 W	.75-10 kg	
	Insecticidal Soap	10 L	
Leafroller	Dipel	1.0-1.25 kg	
	Thuricide HPC	5 L	
	Orthene 75% SP	850 g	
Midge	Orthene 75% SP	850 g	
	Parathion Smoke Fumigator		1/300 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
	Diazinon 50% WP or Diazinon 50% EC	1.0-1.5 kg. (soil drench) 1.25 L	
Thrips	Trumpet 80W	.75-1.0 kg	1.25 kg/ha
	Diazinon 50% WP or Diazinon EC	1.0-1.5 kg (soil drench)	
	Orthene 75 SP	850 g	
Twospotted Spider Mite	Pentac Aqua Flow or Pentac 50% WP	650 mL 625 g	
	Kelthane 18.5 EC or Kelthane 35% WP	1.25 L 750 g	
	Vendex 50% WP	0.5-1.0 kg	
	Plictran 50% WP	250-375 g	
	Insecticidal Soap	20 L	
Whitefly	Ambush 50 EC	200 mL	
	Insecticidal Soap	10 L	
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Trumpet 80 W	.75-1.0 kg	
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	Orthene 75% SP	850g	
	Pounce 384 EC	275 mL	
Black Spot	Benlate 50% WP + Manzate 200	500g 2.5 kg	
	Daconil 2787	2.5 L	
	Captan 7.5% Dust or Captan 50% WP or Captan 80% WP	 2.0 kg 1.5 kg	
	Zineb 3.9% Dust		
Powdery Mildew	Meltatox 40% EC Acti-Dione P.M.	2.5 L 3.13 kg	
	Benlate 50% WP + Manzate 200	 2.5 kg	
Botrytis	Rovral 50 WP	1.0 kg	
	Daconil 2787	2.5 L	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
		SNAPDRAGON	
Aphid	Pirimor 50% WP	500 g	
	Nicotine Smoke Fumigator		1/300 m^3
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Dibrom Insecticide		10 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Trumpet 80W	.75-1.0 kg	
	Insecticidal Soap	20 L	
Cyclamen Mite	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
Thrips	Diazinon 50% WP or Diazinon 50% EC	1.0-1.5 kg 0.63-1.25 L	
	Trumpet 80 W	.75-1.0 kg	1.25 kg/ha drench
	Lindane Smoke Fumigator or Lindane Fog Solution		1/300m^3 35 mL/100 m^3
Twospotted Spider Mite	Pentac Aqua Flow or Pentac 50% WP	650 mL 625 g	
	Insecticidal Soap	20 L	
	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	Vendex 50% WP	0.5-1.0 kg	
	Plictran 50% WP	250-375	
Whitefly	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Trumpet 80 W	.75-1.0 kg	
	Dibrom Insecticide		10 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Insecticidal Soap	10 L	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Botrytis	Benlate 50% WP + Manzate 200	500g 2.5 kg	
	Exotherm Termil Smoke Fumigator		1/300 m^3
	Captan 7.5% Dust or Captan 50% WP or Captan 80% WP	 2.0 kg 1.5 kg	
	Daconil 2787	2.5 L	
	Rovral 50% WP	1.0 kg	
Powdery Mildew	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
Stem Rot	Lesan 35% WP	450-900 g Apply to 100 m^2	
	Truban 30% WP	175-625 g	

GREENHOUSE VEGETABLES

Crop Protection

Note: the information on the following pages, no's 51 to 58 pertains to greenhouse vegetable crops only. For flower crop protection information, refer to pages 21 to 50. It is important that you DO NOT interchange the pest control recommendations between the two sections.

Regulations of Health and Welfare Canada have established the amounts of insecticides and fungicides that are permitted to remain on or in food crops at time of harvest. To avoid exceeding such amounts, follow recommendations exactly. Residues of an unregistered pesticide on a marketed crop, or excessive residues of a registered pesticide may lead to its seizure, and prosecution. Safe intervals between the last application of a material and harvest are given in days and enclosed in brackets after each material mentioned in the text. Where two or more materials are mixed, the interval from treatment to harvest must be that of the material having the longest interval.

All pesticide chemicals should be treated as poisons and should be stored in a safe place, well away from children, irresponsible persons, pets, livestock, etc. (see pesticide storage, page 6).

Under certain conditions pesticides may cause plant injury. Where possible it is best to test pesticides and especially pesticide mixtures, on a few plants first to check the plant safety factor under your own conditions. Read the warnings on the label and consult the manufacturer's information regarding compatibility before using combinations that are not mentioned.

Many pesticides degrade quite rapidly, especially in alkaline water. Mix only in quantities that can be immediately applied (1-2 hours). (see p 7).

Also read:
Precautions with all pesticides — page 3
If accidents occur — page 3
Pesticide poisoning — page 3
Blood Tests for Those Applying Pesticides — page 5
Protective Clothing When Using Pesticides in Greenhouses — page 5
Relative Hazards to Humans of Recommended Pesticides — page 3

NOTE: Over a period of time an insect or disease may become resistant or immune to certain pesticides. Therefore it is advisable to make alternate applications of the recommended pesticides, where possible.

The recommendations which follow have been revised by the Ontario Pesticides Advisory Committee. Before using any chemical, read carefully the sections on pages 3 to 8 dealing with Pesticide Poisoning, Relative Toxicities of Recommended Pesticides and Reentry to Treated Areas after treating with pesticides. All pesticide products are registered by Agriculture Canada. No pesticide may be used on any crop for which it is not registered. Such use can result in seizure of the crop.

Monitoring Insect Outbreaks

Insects such as the greenhouse whitefly, thrips and leaf miners are attracted to shades of yellow and will fly towards that color. Thus, insect traps can be made by painting pieces of board with the correct shade of yellow pigment and then covering the paint with a sticky substance. Similar traps are available commercially from several sources. By placing a number of traps within the greenhouse range it is possible to check infestations daily and be aware of early infestations. Control programs can then be commenced while populations are low.

The two-spotted mite cannot be trapped in this way, but infestations usually begin in localized areas first. Check cucumber leaves daily and begin control measures as soon as the first infested areas are noted.

Biological Control and Integrated Control.

1. Biological Control. Several greenhouse vegetable pests can be partially or totally controlled by introducing into the greenhouses, colonies of their natural parasites or predators, that destroy the pest population without injuring the crop. This is known as Biological Control and pests that can be successfully controlled by this method include:

Greenhouse whitefly — controlled by the parasitic wasp Encarsia formosa

Two-spotted mite — controlled by the predator mite Phytoseiculus persimilis

Aphids — controlled by the predator Aphidoletes aphidimyza.

Note: A parasite is an organism (insect) that develops within the body of its host, and eventually kills it; a predator attacks and devours its prey.

For information on obtaining parasites and predators, consult your greenhouse vegetable crop advisor (page 2).

2. Integrated Control. This involves a combination of biological control with the use of pesticides. To be successful, the biological agent must be resistant to the pesticide as in the case of two-spotted mite control on cucumber, using predators plus the miticide Vendex (see page 55).

Rockwool, Peat Bags, Nutrient Film Technique

At the present time, most greenhouse vegetable crops in Ontario are grown in soil. However, there has been interest in, and a trend toward, production in artificial media (substrates) such as rockwool, peat bags and nutrient film (n.f.t.). From a crop protection viewpoint, these production systems have several advantages such as:

(1) Elimination of soil drainage problems which favour disease development.

(2) Warmer temperatures in the root zone, reducing disease problems associated with cold soil.

(3) Prevention of nematode damage. Artificial media are nematode free, thus negating the need for sterilization (page 9).

If the crop you want to spray or dust is not listed on the label, do not use the pesticide.

NOTE: If such media are re-used for more than one crop, sterilization between crops may be necessary.

Growers who have had persistent soil disease or nematode problems may wish to consider substrates. It is advisable to study all the available literature and to consult with one or more greenhouse men who have switched to a substrate system. Your vegetable crops advisor (page 2) can provide reference material and names of growers and for consultants who are knowledgeable in this field.

Seed Treatment

(1) Hot Water Treatment — Tomato

This treatment is recommended especially where bacterial canker has occurred in previous crops. Many seed companies routinely hot water treat their greenhouse tomato seed before packaging. If this has not been done, place tomato seed in a loose cheesecloth bag and soak in water at 50°C for 30 minutes. The treatment may be carried out at 54°C for 30 minutes if the seed is planted within a few days. Use an accurate thermometer and stir the water frequently during treatment. Spread seed out to dry immediately after treatment.

(2) Chemical Treatment — Tomato

To destroy tomato mosaic virus on seed coat, treat tomato seed a day or two before sowing. Soak seed for 15 minutes in solution of trisodium phosphate 100 g in 1 L of water. Rinse seed thoroughly with warm water. Spread out to dry.

(3) Seed Protectants

To protect all greenhouse vegetable seedlings against soil-borne damping-off fungi, treat the seed with protectant fungicide before sowing, e.g. thiram or captan. Follow manufacturer's directions.

Cucumber Disease Control

For a general description of cucumber diseases, see Agriculture Canada Publication 1684, *Cucumber Diseases*. (page 61)

Angular Leaf Spot

At first appearance, spray or dust with Fixed Copper, as per manufacturer's directions. (1 day).

Bacterial Wilt

A sudden wilt of cucumber caused by bacteria that are carried in the gut of cucumber beetles. Infection is transmitted by beetle feeding. July, August, September planted crops are most likely to be attacked, especially if there are cucurbit crops,such as melons, squash, pumpkins etc. growing in fields nearby. See cucumber beetles control, page 54.

Basal Stem Rot and Root Rot

Before planting sterilize the soil with steam, or use a soil fumigant (see Soil Sterilization, page 9). Transplant into a well prepared, warm soil (temperature 20°C). Apply a ferbam spray and avoid cold water shock as described on page 52 for late damping off.

Black Root Rot

Diseased plants tend to wilt on sunny days, but may recover at night. With the aid of a hand lens, examine the roots of such plants for small, long titudinal black lesions. If black root rot is discovered at an early stage, mound the bases of the stems with a soil peat mixture to encourage new root growth. The mound should cover the area of the first leaf scar. Where black root rot is a persistent problem, consider:

1) Artificial media
2) Grafting to the disease tolerant root stock Cucurbita fiafolia, for crops to be grown in soil beds. Soil pasteurization with steam (p 9) is the most effective control in soil beds. Ensure that soil bed temperatures are adequate (20°C) before planting.

Cucumber Mosaic Virus

Many seedless varieties are highly susceptible to cucumber mosaic, especially when it occurs in combination with certain soil-borne fungi (e.g. **Pythium).** It is almost impossible to keep summer and fall plantings free from mosaic, especially in southwestern Ontario.

The virus is spread by aphids and by handling plants. Infected plants usually wilt and die within a few days. Control aphids. See sanitation (page 9).

Burpee hybrid and High Mark II seeded cucumbers are moderately resistant. A few seedless cucumber cultivars have a degree of tolerance. Consult your vegetable crops advisor (page 2).

Damping-off

Use only vigorous transplants that show no sign of disease. Transplant into a well prepared, warm soil (temperature 20-21°C) that has been steamed or fumigated (page 9). Be sure that toxic gases from fumigants have disappeared. Determine this by setting a few plants in the soil at least 3 days before planting the greenhouse. Immediately after transplanting, spray the base of the plants with Ferbam 76% WP, 1.5 Kg per 1000 L of water. Avoid cold water shock to young plants by pre-heating the irrigation water to 21°C.

Damping-off caused by **Pythium SPP.** can be a serious problem in artificial media such as Rockwool or Peat especially when re-used for second or third crops. Before re-using such media, it should be allowed to dry out for aeration and/or pasteurized (p 9).

Read and follow label directions when applying any pesticide.

Downy Mildew

Occasionally a problem in August-September planted seedless cucumber crops. Reduce humidity and provide good air circulation. Apply a little heat on cool nights to prevent moisture condensation on the leaves. If the disease appears, spray thoroughly with:

Benlate 50 WP:	550-850 g. plus 2.25 kg. Manzate 200 (5 days), or
Maneb 80% WP	2 kg (3 days), or
Fixed Copper —	Use manufacturer's directions, or
Zineb 80% WP	1.75-2.75 kg. (5 days)

Gray Mold (Botrytis)

Often becomes serious in spring (March-May) and in autumn (September-November). Reduce humidity, provide good air circulation and ventilate freely. Provide adequate heat on cool nights. Remove old leaves and suckers carefully, leaving no snags or tears. Take away all prunings and plant debris from infected crops. Diseased areas on stems may recover if scraped and covered with a fungicide paste of Ferbam 76% WP, or Rovral 50% WP.

Spray at weekly intervals until the disease is checked with

Ferbam 76% WP	1.5 kg.	(1 day) or
Rovral 50 WP	1 kg.	(2 days)

NOTE: (1) Alternate between the recommended fungicides to delay resistance build-up.
(2) The above materials will also help control gummy stem blight.

Gummy Stem Blight

Provide adequate heat and do not allow the crop to sweat at night. Avoid overhead irrigation. This disease is readily spread on fingers, tools and by water splash. Strict sanitation must be practised at all times. Fruit which is suspected of having gummy stem blight should not be included in marketing consignments.

At first appearance of the disease spray at 7-10 day intervals with

Benlate 50 WP 550-850 g. plus 2.25 kg.
Manzate 200 (5 days)

Fungicides used to control Grey mold (Botrytis) also help control gummy stem blight.
Alternate between the recommended fungicides to delay resistance build-up.

Leaf Spots (Alternaria, Anthracnose)

At first appearance, spray with Maneb 80% WP, 750 g (5 days), or Benlate 50 W, 550-850 g plus 2.25 kg. Manzate 200 (5 days)

Post Harvest Breakdown

Under certain conditions seedless cucumbers will deteriorate very quickly after harvest. Several diseases may be involved, including gummy stem blight and scab. The breakdown is most frequently seen when several unseasonably cool nights alternate with hot, sunny days in later summer months. It also occurs when storage periods are prolonged after picking, especially at improper temperatures and in poorly ventilated areas. There is no one method of preventing this condition, but especially in summer when you have hot sunny days and below normal temperatures at night take care to:

(1) prevent disease outbreaks

(2) avoid water condensation on the cucumbers, i.e. "sweating" by providing a little heat at night

(3) avoid overloading, which weakens the plants and causes unhealthy cucumbers that lack turgidity

(4) harvest cucumbers with a sharp knife, leaving a 1-2 mm stem on each fruit

(5) avoid tearing, fruit bruises, cuts and abrasions

(6) maintain the temperature for marketing and storing at 10-15°C and ideally at 12°C. The relative humidity of the storage area should be between 85 and 95%.

(7) avoid accumulation of ethylene gas in the storage areas by keeping cucumbers away from apples, tomatoes and other fruits and by adequate ventilation.

Powdery Mildew

Follow strict sanitation practices (page 9). Grow seedlings in an area that is completely isolated from greenhouses where the previous season's crops are still growing, OR delay starting new seedlings for several weeks after destroying all plants, weeds and debris from the previous crop.
When powdery mildew appears, spray at weekly intervals as required with:
(1) Micro-Niasul — 92% wettable suphur ¼-1.5 kg (1 day)
Caution: a build-up of sulphur residue resulting from repeated applications of spray, may injure cucumber leaves, especially if greenhouse temperatures rise above 29-32°C. Repeated sprays are seldom needed under such temperatures but if they are, remove old residues by syringing the plants with water before re-spraying.
A late infestation of powdery mildew may occur during the cucumber harvest season in April, May or June. It is frequently possible to obtain at least partial control by syringing the plants with water, using moderate pressure. This of course increases the humidity which may cause further development of other diseases. Therefore, after syringing, ventilate as much as possible so the plants will dry off before the sun goes down.

A few European seedless cucumber cultivars have a degree of tolerance to powdery mildew. Trial plantings may be advisable.

Pseudo Yellow Virus

A disease new to Ontario seedless cucumber crops that is spread by the greenhouse whitefly. Symptoms are chlorotic yellowing between the veins of older leaves and interveinal yellow spotting on intermediate leaves. Upper foliage may remain

Amounts of material are for 1000 litres of water unless otherwise stated.

unaffected during the early stages. Diseased plants become less productive. There is no known method of control except to control whiteflies (page 54). Beets, several species of weeds, and lettuce are known to be alternate hosts. Therefore the practice of alternating leaf lettuce crops with seedless cucumbers may not be advisable. Also see Sanitation, (page 9).

Scab

Most likely to become a problem in single layer plastic houses, especially under conditions of cool nights when water forms on the cucumbers, followed by sunny days. Cucumber scab may contribute to post harvest breakdown. Maintain night temperatures at or above 18°C. Provide good ventilation and air circulation, to reduce humidity, especially in plastic greenhouses.

Sprays applied for leaf spot (page 53) will also help control cucumber scab.

Wilting

In the absence of disease or nematodes, wilting often occurs during April and May when warm sunny days follow prolonged cloudy periods, especially on seeded cucumber. Most common causes are unfavorable temperatures, high salts and inadequate root systems. Plants usually recover within a few weeks but frequently some of the lower leaves and occasionally a few of the plants die. Mounding the base of affected plants with soil (preferably muck) to cover the first joint promotes new root growth and hastens recovery. Syringing with water on very hot days may reduce the amount of wilting. (See paragraph 3 under Powder Mildew Control).

Sudden Wilt of Seedless Cucumber

This disorder is similar to wilting as described above, but differs in that the root system does not show signs of major decay, and the plants are less likely to recover. Total collapse of the entire plant may be very sudden. All factors that may contribute to sudden wilt are not understood, but investigations have shown that a combination of cucumber mosaic virus and the damping-off fungus **Pythium spp.** is frequently involved. All practices that help prevent damping-off (page 52) and cucumber mosaic virus (page 52) should be carefully followed.

Cucumber Insect Control

Aphids

Prevent aphids from entering the greenhouse by screening the vents and eliminating weeds around the outside. Apply one of the following if aphids are noticed on the lower surface of cucumber leaves:

(1) Greenhouse Dibrom 20 mL/100 m³ on heating pipes (1 day) CAUTION: Repeated applications, or single applications at above the recommended dosage, may injure seedless cucumber blossoms.

(2) Thiodan 50% WP 1 kg or Thiodan 4 EC 1¼-1½ L (1 day)

(3) Parathion smokes (1 day)

(4) Nicotine smokes (1 day)

(5) Aphid predators (page 51) — will provide adequate control under optimum conditions.

Cucumber Beetle

This insect spreads Bacterial wilt disease (page 52). Prevent the beetles from entering greenhouses by screening all ventilators and doors especially during late spring, summer and fall when the beetles are prevalent. If additional control is needed, consult your vegetable crops advisor re effective insecticides (page 2).

Greenhouse whitefly

I. Sticky yellow boards or tapes will trap whitefly adults. This gives an early indication that whiteflies are present. (See Monitoring Insect Outbreaks, page 51)

II. **Biological Control**
The small parasitic wasp **Encarsia formosa** deposits its eggs within whitefly eggs or larvae, and kills the developing whiteflies by growing within their bodies. Introduce parasites when adult whiteflies are first noticed, and before they become abundant. You must learn to recognize the very small, black and yellow adult parasites. Monitor your crop closely for indications of parasite activity. A parasitized whitefly nymph turns black and an adult parasite emerges later on. Whiteflies will decline in numbers when the parasite completes several generations, and both whiteflies and parasites will stay at low numbers.
For information on obtaining parasites, and for assistance in recognizing the small adult wasps, consult your vegetable crops advisor (page 2). See also page 51.

III. **Chemical Control**
(1) Greenhouse Dibrom 20 mL/100 m³ on heating pipes (1 day). Caution: Repeated applications, or single applications above the recommended dosage, may injure seedless cucumber blossoms.
(2) Thiodan 50% WP 1 kg or Thiodan 4 EC 1¼-1½ L (1 day). Note: Many strains of whitefly are resistant to Thiodan; others may develop resistance after repeated applications.
(3) Parathion smokes (1 day). Generally effective only against light infestations and in small greenhouse areas.
(4) Permethrin e.g. Ambush 500 EC 200 mL (1 day), or Pounce 384 EC 260 mL (1 day). (Note: Resistance has developed in many areas.

The above materials mainly control adults. Repeat applications at 5-day intervals to prevent egg-laying by newly emerged adults.

Root-Knot Nematode

Before planting, steam the soil or use a soil fumigant (page 9) according to label directions. When the crop is grown in artificial media, nematodes are less likely to be a problem. However, rockwool or peat bags should be sterilized before re-use.

Read and follow label directions when applying any pesticide.

Thrips

Use chemical controls as recommended for greenhouse whitefly.

Twospotted Mite

As soon as the first mite injury is seen remove and destroy all infested leaves. Then begin biological and/or chemical control measures on these plants and the surrounding ones.

I. Biological Control — The biological control program uses the predator **Phytoseiulus persimilis** which feeds on all stages of the twospotted mite. This predator is also a mite, but it does not feed on plants, and it can be distinguished by its orange color. The predators, which are slightly larger than the twospotted mite, should be placed on the mite-infested cucumbers at a rate of 5 per plant. Examine the plants regularly to check that predators are established. They can be moved on a piece of leaf to other newly infested cucumber plants. See also Biological Control and Integrated Control, (page 51).

II. Chemical Control — Spray must be applied to cover both upper and lower leaf surfaces. Mites multiply very rapidly at temperatures over 20°C so April, May and June are critical months. Recommended miticides are:

(1) Vendex 50 W, 500 g — 1 kg (5 days) also helpful where biological control is used because Vendex does not harm the predators. Efficiency is increased when a spreader-sticker is added.

(2) Kelthane AP 35% — 750 g (3 days)

(3) Tedion smokes — (1 day)

(4) Greenhouse Dibrom 20 mL/100 m^3 on heating pipes (1 day). Caution: Repeated applications, or single treatments at above the recommended dosage may injure seedless cucumber blossoms.

Note: Do not rely on one product for a prolonged period. Alternate between the recommended pesticides. See Sanitation (page 9).

Tomato Disease Control

For general descriptions of tomato diseases, see Agriculture Canada Publication 1479: **Tomato Diseases.** (See Inside Back Cover).

Resistance Code: Packets of greenhouse tomato seed, and also their descriptions in most seed catalogs, use the following symbols to indicate the diseases to which the cultivar is resistant.

C_2	— leaf mold partial resistance
C_5	— leaf mold complete resistance
F_1	— fusarium wilt — race 1
F_2	— fusarium wilt — race 1 & 2
FCRR	— fusarium crown and root rot
N	— nematode resistance
Tm	— tomato mosaic virus
V	— verticillium resistance

Bacterial Canker

(1) Hot Water Seed Treatment (see p 52).
(2) Follow a rigid schedule of sanitation throughout the growing season (page 9).
(3) Remove and immediately destroy diseased plants as soon as they are noticed.
(4) Follow other good sanitary practises and spray with fixed copper (1 day) at 7 day intervals, or with a tank mix of fixed copper (1 kg) and mancozeb (1 kg). (1 day).
(5) See Publication 1479: Tomato Diseases, pages 31-33 (page 61).

Bacterial Stem Rot

First symptom is a sudden wilting of a few tomato plants, often scattered throughout the greenhouse. Plants so attacked will have hollow stems which may be partially filled with decaying plant tissue which has a foul odour. Soft, vigorously growing plants are often the first attacked. Although not serious in Ontario greenhouses to date, the disease merits further study. Contact your Vegetable Crops Advisor or the Pathology Section, Research Station Agriculture Canada, Harrow, Ontario, N0R 1G0, if the disease occurs.

Blossom End Rot

A non-parasitic disease that is related to water stress and calcium deficiency. If rapidly growing plants are suddenly exposed to drought, insufficient water enters the plant and blossom end rot frequently occurs. Practise uniform watering, keep calcium levels adequate and avoid high rates of nitrogen application when plants are small.

Blotchy Ripening

Provide adequate space per plant, i.e. 0.33-0.42 m^2 (3½-4½ sq. ft.); control virus diseases (page 56) and maintain relatively high potash levels. Keep greenhouse temperature as low as possible in hot weather. Avoid varieties known to be susceptible to blotch.

Corky Root

Thorough soil pasteurization with steam or fumigation with Methyl bromide (page 10) is the only fully effective control. There are no registered post planting controls. Where the disease is persistant in the soil in spite of pasteurization or fumigation, crop production in artificial media should be considered.

Damping-off

(a) Seedlings
1. Treat seed with a reliable fungicide before sowing. (Page 52.)
2. Plant seed in a pasteurized soil or disease free media.
3. Raise seedlings on benches, not on the floor to provide bottom heat.
4. Provide adequate moisture by frequently misting or watering lightly, but do not over water. Preheat the irrigation water to 21°C.
5. Maintain good air movement in the seedling area. Ventilate freely but do not chill. Keep humidity low.

Amounts of material are for 1000 litres of water unless otherwise stated.

6. Dust or drench diseased areas with a suitable fungicide such as captan, ferbam or No-damp.

(b) Late Damping-off (Collar Rot)

Several species of fungi, either alone or in combination, may attack newly transplanted tomato seedlings at ground level. The fungi cause browning and decay of the outer layers of stem tissue, resulting in either total collapse of the plant, or severe retardation of growth. To control, sterilize the plant beds thoroughly, and practise strict sanitation. Transplant seedlings into a warm soil. After transplanting, spray the stems and surrounding soil with Botran 75% (1.25 kg), or Ferbam 76% WP (1.5 kg). Repeat in 7-10 days. Avoid cold water shock by pre-heating the irrigation water to 21°C.

Early Blight, Late Blight, Septoria Leaf Spot

Spray with one of the following to keep new growth covered:

(1) Mancozeb WP: 2 kg (1 day)

(2) Maneb WP: 2 kg (3 days)

(3) Zineb WP: 1.75-2.75 kg (5 days)

Fusarium Crown and Root Rot

A severe disease of spring and fall tomato crops that first appeared in 1974. Earliest visible symptoms are wilting on sunny days, especially when the plants are carrying a heavy load. Related symptoms are thinner than usual tops, and chocolate brown internal stem lesions at soil level.

The disease can be reduced by steaming the soil immediately after taking out the spring crop, and either leaving the ground fallow or preferably growing lettuce to be harvested or rotovated in. No further sterilization is necessary before planting the next crop.

Infection is spread very fast from soil with wilted plants and it is very important to raise seedlings in hygienic conditions well away from affected crops and unsterilized soil. Keep the greenhouses and surrounding areas clear of soil piles, trash, etc. that may harbor the disease. Ensure that soil temperature is adequate for planting. Avoid cold water chilling.

In the fruiting crop, soil mounded over layered stems will encourage new root production from the stem, above the diseased area.

Resistant pink fruited cultivars are now available. Resistant red cultivars should be available soon. Contact your vegetable crops advisor (page 2).

Fusarium Wilt, Verticillium Wilt, Black Dot Root Rot *(Colletotrichum)*

Before planting, steam soil or apply a soil fumigant (page 10). Many of the newer tomato cultivars are either partially or totally resistant. Check the resistance code on your seed package. For information on resistance code, see page 55.

Gray Mold *(Botrytis)*

Often becomes serious in spring (March-May) and in the autumn (September-November). Reduce humidity, provide good air circulation, ventilate freely, and apply one of:

1. Botran 75% WP 1.25 kg (1 day). Spray stem of plant from ground level to a height of 45-60 cm. Repeat weekly or as necessary. Seedlings or newly set transplants may be injured by drenching.

2. Ferbam 76% WP 1.5 kg (1 day)

3. Rovral 50% WP 1 kg (2 days). Alternate with other recommended fungicides, or

4. Benlate 50 WP 1.1 kg plus 2.25 kg Manzate 200 (1 day). Note: Many strains of *Botrytis* are resistant to Benlate. Alternate with other recommended fungicides.

5. Exotherm Termil smoke generators (1 day). Do not apply at temperatures above 24°C.

Leaf Mold

Grow resistant cultivars where possible (see resistance code, page 55). If susceptible varieties are grown, apply heat and provide good air circulation and ventilate. Remove diseased lower leaves if infection is severe. When leaf mold first appears spray with Benlate 1.1 kg plus 2.25 kg Manzate 200 (1 day). Repeat at 7-12 day intervals.

Magnesium Deficiency

This will cause older leaves to turn pale green or yellow between the veins. At first appearance of this symptom, apply magnesium sulfate (Epsom salts) two or three times to the soil at 1-1½ kg/100 m^2 or to the leaves as a spray 5 kg in 1000 L water. In greenhouses where the problem has occurred on previous crops, magnesium sprays should be applied even before the symptoms occur. High potassium level in the soil may induce magnesium deficiency.

Tomato Mosaic Virus, Streak Virus, Shoestring

1. Grow cultivars resistant to or tolerant to TMV (tomato mosaic virus) (see resistance code, page 55).

2. Rogue out affected seedlings and plants if disease appears early. After handling diseased plants, field tomatoes, potatoes, bedding plants, and after smoking or handling tobacco in any form, wash hands with soap and water because virus may be carried to greenhouse plants from such sources. Disinfect tools and boots and launder clothing.

3. Infection with both TMV and Potato Virus X (from potatoes) causes streak virus which severely damages tomato plants. Never handle potato tubers, vines, etc. and then proceed to work in your tomato crop.

4. Shoestring is caused by cucumber mosaic virus and is easily transmitted to tomato from cucumbers, melons or several

Read and follow label directions when applying pesticides.

species of weeds. Infection is most severe if it occurs when the tomato plants are very young, i.e. seedling and early transplant stage. Do not grow cucumbers close to the tomato crop or work with tomatoes after handling a cucumber crop that has mosaic.

5. Control aphids.

6. Seed treatment with Trisodium phosphate (page 52) will help destroy TMV on the seed coat.

Tomato Insect Control

Aphids

Aphids mostly start on lower leaves and if noticed soon enough they can be eliminated by removing and destroying the infested leaves. If the aphids are more abundant or widespread apply one of the following according to label directions:

1. Greenhouse Dibrom 20 mL/100 m^3 on heating pipes (1 day)

2. Parathion smokes (1 day)

3. Nicotine smokes or pressure fumigators (1 day)

4. Thiodan 50% WP 1 kg or Thiodan 4 EC 1¼-1½ L
   OR 3% dust 250 g/100 m^2 (1 day)

5. Aphid Predators will provide adequate control under optimum conditions. (See page 51).

NOTE: The insecticides listed for aphid control on the previous page are effective against several species of aphids that attack tomatoes, but only Nicotine smokes will kill the green peach aphid which may attack tomatoes. If in doubt as to species, consult your vegetable crops advisor (page 2).

Corn Earworm, Corn Borer, Cabbage Loopers

Often invade fall crops and bore into the fruit. At first appearance, spray with Dipel 1¼ kg or Thuricide HPC 2.8 - 5 L (1 day). Prevent entry of adults (moths) by screening doors and ventilators.

Cutworms

Apply a poison bran bait to the soil surface at 1¼ kg/100 m^2. The bait consists of Sevin 50% WP 1 kg stirred into 11 L water, mixed with 12 kg bran.

Greenhouse Whitefly

See sanitation, page 9.

For biological control, see recommendations for cucumber (page 54).

For chemical control, use one of the following:

1. Greenhouse Dibrom 20 mL/100 m on heating pipes (1 day)

2. Thiodan 50% WP 1 kg OR Thidan 4 EC 1¼-1½ L (1 day).
   NOTE: Many strains of whitefly are resistant to Thiodan; others may develop resistance after repeated applications.

3. Parathion smokes (1 day). Generally effective only against light infestations and in small greenhouse areas.

4. Permethrin
   e.g. Ambush 500 EC 200 mL (1 day) or Pounce 384 EC 260 mL (1 day) (Note: resistance has developed in many areas.)

The above materials mainly control adults. Repeat application at 5-day intervals to prevent egg laying by newly emerged adults. Alternate between insecticides to prevent the further build-up of resistance.

Leaf Miner

Leaf miner has been an occasional problem in greenhouse tomato crops. If seedlings for the spring crop are started while the previous fall crop is still in the greenhouses, leaf miners will migrate from one to the other. Therefore grow seedlings in isolated areas. Control all weeds and other vegetation which might provide alternate host material for leaf miners. Monitor leaf miner populations by using sticky yellow boards to trap adults (see page 54). Control measures must begin when adults first appear. Spray with:

1. Ambush 50 EC, used as for greenhouse whitefly will also help control leaf miners, or apply

2. Malathion 25% WP 4 kg (3 days) or Malathion 500 EC 1¼ L (3 days). Repeat at 4-day intervals.

NOTE: Several species of parasitic wasps that occur naturally in the environment, are very helpful in controlling leaf miners.

Root-Knot Nematode

Use control as cucumber (page 54).

Thrips

Seldom troublesome on tomatoes. If required use one of the chemicals listed for greenhouse whitefly.

Two-Spotted Spider Mite

Rarely a pest on tomatoes in Ontario but a few recently introduced cultivars appear to be more susceptible to damage. Because cucumbers are very susceptible to spider mite damage, it is not advisable to grow tomatoes close to cucumber plants. If required, use control as for cucumber (page 55).

Lettuce Disease Control

Damping off and Bottom Rot in Lettuce

Certain fungi such as Botrytis, Rhizoctonia and Sclerotimia can cause damping off of lettuce seedlings, or root decay and rotting

Amounts of material are for 1000 litres of water unless otherwise stated.

at ground level (bottom rot) if the attack occurs later in the growing season.

Thoroughly sterilize the soil with steam (page 9) in severely infested greenhouses. Provide adequate moisture but do not overwater. Maintain good air movement in the greenhouse. Ventilate freely; keep humidity at moderate levels.

Spray seedlings before transplanting with ferbam 76% WP 1.5 kg, or apply a ferbam dust. Repeat once or twice after transplanting, as needed, at 7-10 day intervals.

Downy Mildew

Occasionally a problem in late summer and fall crops, especially in plastic greenhouses where high humidity occurs. Provide adequate temperature and ventilation to avoid prolonged periods of leaf wetness.

If the disease appears, spray thoroughly with:

Zineb 80% WP — 1.75-2.25 kg (10 days), or
Maneb 80% WP — 1.75-2.25 kg (7 days) or apply
Zineb dust (10 days) as per manufacturer's directions.

Lettuce and Radish Insect Control

Aphids

Nicotine smokes or pressure fumigants (1 day).

Cabbageworms, Loopers and other Caterpillars

Often troublesome in early fall. Spray with Dipel 1¼ kg or Thurcide HPC 2.8-3.5 L (1 day).

All pesticide products are registered by Agriculture Canada. No pesticide may be used on any crop or which it is not registered. Such use can result in seizure of the crop.

Read and follow label directions when applying pesticides.

METRIC INFORMATION

THE METRIC SYSTEM

Linear Measures (length)

10 millimetres (mm) = 1 centimetre (cm)
100 centimetres (cm) = 1 metre (m)
1000 metres = 1 kilometre (km)

Square Measures (area)

100 m x 100 m = 10,000 m^2 = 1 hectare (ha)
100 ha = 1 square kilometre (km^2)

Cubic Measures (volume)

Dry Measure

1000 cubic millimetres (mm^3) = 1 cubic centimetre (cm^3)
1,000,000 cm^3 = 1 cubic metre (m^3)

Liquid Measure

1000 millilitres (mL) = 1 litre (L)
100 L = 1 hectolitre (hL)

Weight — Volume Equivalents (for water)

(1.00 kg) 1000 grams = 1 litre (1.00 L)
(0.05 kg) 500 g = 500 mL (0.05 L)
(0.10 kg) 100 g = 100 mL (0.10 L)
(0.01 kg) 10 g = 10 mL (0.01 L)
(0.001 kg) 1 g = 1 mL (0.001 L)

Weight Measures

1000 milligrams (mg) = 1 gram (g)
1000 g = 1 kilogram (kg)
1000 kg = 1 tonne (t)
1 mg/kg = 1 part per million (ppm)

Dry — Liquid Equivalents

1 cm^3 = mL
1 m^3 = 1000 L

APPLICATION RATE CONVERSIONS
(approximate)

Metric to Imperial (Approximate)

litres per hectare x 0.09	=	gallons per acre
litres per hectare x 0.36	=	quarts per acre
litres per hectare x 0.71	=	pints per acre
millilitres per hectare x 0.015	=	fluid ounces per acre
grams per hectare x 0.015	=	ounces per acre
kilograms per hectare x 0.89	=	pounds per acre
tonnes per hectare x 0.45	=	tons per acre

Imperial to Metric (Approximate)

gallons per acre x 11.23	=	litres per hectare (L/ha)
quarts per acre x 2.8	=	litres per hectare (L/ha)
pints per acre x 1.4	=	litres per hectare (L/ha)
fluid ounces per acre x 70	=	millilitres per hectare (mL/ha)
tons per acre x 2.24	=	tonnes per hectare (t/ha)
pounds per acre x 1.12	=	kilograms per hectare (kg/ha)
ounces per acre x 70	=	grams per hectare (g/ha)

Dry-Weight Equivalents

Grams or Kilograms per Hectare		Approximate Ounces or Pounds per Acre
100 grams	=	1½ ounces
200 grams	=	3 ounces
300 grams	=	4¼ ounces
500 grams	=	7 ounces
700 grams	=	10 ounces
1.10 kilograms	=	1 pound
1.50 kilograms	=	1¼ pounds
2.00 kilograms	=	1¾ pounds
2.50 kilograms	=	2¼ pounds
3.25 kilograms	=	3 pounds
4.00 kilograms	=	3½ pounds
5.00 kilograms	=	4½ pounds
6.00 kilograms	=	5¼ pounds
7.50 kilograms	=	6¾ pounds
9.00 kilograms	=	8 pounds
11.00 kilograms	=	10 pounds
13.00 kilograms	=	11½ pounds
15.00 kilograms	=	13½ pounds

Liquid Equivalents

Litres/Hectare		Approximate Gallons/Acre
50	=	5
100	=	10
150	=	15
200	=	20
250	=	25
300	=	30

CONVERSION TABLES — METRIC TO IMPERIAL

Length

1 millimetre (mm)	= 0.04 inch
1 centimetre (cm)	= 0.40 inch
1 metre (m)	= 39.40 inches
1 metre (m)	= 3.28 feet
1 metre (m)	= 1.09 yards
1 kilometre	= 0.62 mile

Area

1 square centimetre (cm^2)	= 0.16 square inch
1 square metre (m^2)	= 10.77 square feet
1 square metre (m^2)	= 1.20 square yards
1 square kilometre (km^2)	= 0.39 square mile
1 hectare (ha)	= 107,636 square feet
1 hectare (ha)	= 2.5 acres

Volume (liquid)

1 millilitre (mL)	= 0.035 fluid ounce
1 litre (L)	= 1.76 pints
1 litre (L)	= 0.88 quart
1 litre (L)	= 0.22 gallon (Imperial)
1 litre (L)	= 0.26 gallon (U.S.)

Volume (dry)

1 cubic centimetre (cm^3)	= 0.061 cubic inch
1 cubic metre (m^3)	= 1.31 cubic yards
1 cubic metre (m^3)	= 35.31 cubic feet
1000 cubic metres (m^3)	= 0.81 acre-foot
1 hectolitre (hL)	= 2.8 bushels

Weight

1 gram (g)	= 0.035 ounce
1 kilogram (kg)	= 2.21 pounds
1 tonne (t)	= 1.10 short tons
1 tonne (t)	= 2205 pounds

Speed

1 metre per second	= 3.28 feet per second
1 metre per second	= 2.24 miles per hour
1 kilometre per hour	= 0.62 mile per hour

Pressure

1 kilopascal (kPa)	= 0.15 pounds/square inch

Temperature

°F = (°C x 9/5) + 32

°C = (°F − 32) × 5/9

CONVERSION TABLES — IMPERIAL TO METRIC

Length

inch	= 2.54 cm
foot	= 0.30 m
yard	= 0.91 m
mile	= 1.61 km

Area

square foot	= 0.09 m^2
square yard	= 0.84 m^2
acre	= 0.40 ha

Weight

ounce	= 28.35 g
pound	= 453.6 g
ton	= 0.91 tonne

Volume (dry)

cubic yard	= 0.76 m^3
bushel	= 36.37 L

Volume (liquid)

fluid ounce (Imp.)	= 28.41 mL
pint (Imp.)	= 0.57 L
gallon (Imp.)	= 4.55 L
gallon (U.S.)	= 3.79 L

Pressure

pound per square inch	= 6.90 kPa

PUBLICATIONS FOR FURTHER INFORMATION

(1) Ministry of Agriculture and Food

Numbered Publications

27 *Starter Solutions for Vegetable Crops*
40 *Greenhouses*
65 *Energy Conservation in Ontario Greenhouses*
284 *Ontario Farm Record Book (Horticulture & Cash Crops)*
485 *Growing Vegetable Transplants*

Factsheets

250/23 *Vegetable Seed Treatments*
290/092 *Air Pollution Problems in Greenhouses*
290/27 *Using Carbon Dioxide in Greenhouses*
290/518 *Soilless Culture of Greenhouse Vegetables*
290/518 *Sterilization of Greenhouse Vegetable Soils*
290/532 *Leaf Analysis for Greenhouse Vegetable Crops*
290/717 *Commercial Applications of Supplementary Lighting in Greenhouses*
290/717 *Supplementary Lighting in Commercial Greenhouses*
291/635 *Bacterial Canker of Tomato*
292/21 *Growing European Seedless Cucumbers*
293/13 *Greenhouse Lettuce Production*
296/510 *Composts and Soilless Mixes for Transplants*
296/601 *Metrics for Agriculture — Greenhouse and Mushroom Pesticides*
80/062 *Farm Storage of Pesticides*
295/15 *Seed Propogated Free-Flowering Geraniums*

Availble from the communications Branch, Ontario Ministry of Agriculture and Food, Legislative Buildings, Toronto, M7A 1A5 or from County Offices of the Ministry or from the Crops Advisor serving your area. For a complete publication list, obtain the most recent listing from the Communications Branch.

(2) Ministry of the Environment

Personal Protective Equipment for Pesticide Users
Chemical Safety Handbook
Pesticides Act & Regulations
Chemical Storage Signs

Available from Agriculture and Industrial Chemicals Section, Suite 100, Ministry of the Environment, 135 St. Clair Ave. W., Toronto, M4V 1P5

(3) Agriculture Canada

Numbered Publications

#1479 *Tomato Diseases*
#1684 *Cucumber Diseases*

Canadex Factsheet
#614 *Predators and Parasites for Control of Greenhouse Pests*

Available from Information Services, Agriculture Canada, Ottawa, K1A 0C7

Unnumbered Publications

Standby Electric Power (Hydro)

CHOOSE A CAREER WHERE THERE'S ALWAYS A PLACE TO FILL.

Ontario's Colleges of Agricultural Technology offer specialized two-year courses leading to a rewarding career in the food system.

One out of every five jobs in Ontario is connected to the food system, so your career possibilities there are almost endless. However, in many jobs you need some specialized education.

The colleges listed offer a wide variety of courses to give you the training that you need for careers ranging from Food Service Supervisor to Farming to Laboratory Technician. Give yourself a real advantage - call or write for more information:

Centralia College of Agricultural Technology, Huron Park, Ontario N0M 1Y0 Telephone: (519) 228-6691

Collège de technologie agricole et alimentaire d'Alfred, Alfred, Ontario K0B 1A0 Telephone: (613) 679-2218

Kemptville College of Agricultural Technology, Kemptville, Ontario K0G 1J0 Telephone: (613) 258-8335

New Liskeard College of Agricultural Technology, New Liskeard, Ontario Telephone: (705) 647-6738

Ridgetown College of Agricultural Technology, Ridgetown, Ontario N0P 2C0 Telephone: (519) 674-5456

University of Guelph, Guelph, Ontario N1G 2W1 Telephone (519) 824-4120

To receive a free copy of our informative booklet 'Your career in the food system,' just write to any of the colleges listed above.

Ministry of Agriculture and Food
ONTARIO

Jack Riddell, Minister
Clay Switzer, Deputy

RV-1-87-12M
@QUEENS PRINTER FOR ONTARIO, 1987